RISK OF MALNUTRITION AMONG ORALLY COMPROMISED COMMUNITY- LIVING, OLDER ADULTS IN WINNIPEG

BY

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A Thesis
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE

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Faculty of Medicine
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THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

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ABSTRACT

Older adults, who are malnourished but remain undiagnosed due to the similarities between aging and the symptoms of early protein-calorie malnutrition, are at risk for increased morbidity and mortality. Based on evidence that nutritional counseling is effective in changing diet, the Canadian Task Force on Preventive Health Care (1994) recommended screening for protein/calorie malnutrition for certain high-risk groups. Many dental researchers consider edentulous patients to be high-risk and therefore advocate routine dietary counseling for these patients. This assumption results in two questionable outcomes. It suggests that treatment should be performed without diagnosis. It will also result in precluding dentate individuals at nutritional risk from counseling.

The purpose of this preliminary study was to determine the prevalence of malnutrition and risk of malnutrition in orally functional and orally compromised community-living older adults who attend a teaching facility for dental care and to assess further factors associated with risk of malnutrition. The prevalence of malnutrition was determined by using a nutritional screening tool, the Mini Nutritional Assessment. Variables associated with risk of malnutrition were determined by univariate testing from a test instrument against risk of malnutrition. Forward stepwise logistic regression was then utilized to identify the variables that made a unique contribution to a patient's odds of being at risk of malnutrition.

No subjects were determined to be malnourished. Prevalence of risk of malnutrition was 11.6%, with prevalence for orally compromised at 13.9% and for those orally functional at 9.6%. Four variables were identified to be associated

with risk of malnutrition. These variables were then adjusted due to differing age distributions in the sample population to determine the adjusted odds ratio. Subjects with dry mouths were found to be 7.724 times more at risk, those not satisfied with their chewing ability were 5.868 times more at risk, and subjects who grew up in larger urban cities were found to be 7.937 times more at risk for malnutrition. Risk increased 15.8% per year or 4.336 times per decade after age 65. A table was developed to assist in predicting individuals at increased risk of malnutrition. A conceptual model was also developed to assist in demonstrating risk determinants, markers, and indicators responsible for dietary intake and the role of the oral/dental complex in this process.

This preliminary cross-sectional study provides information to oral healthcare providers that risk of malnutrition exists in both orally functional and orally compromised patients. Practitioners who do not wish to perform routine nutritional screening should consider screening based on the variables found to be associated with malnutrition. Modifications to a recommended diagnostic tool, the Mini Nutritional Assessment, were included to reflect these variables for the community-living older adult.

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LIST OF ABBREVIATIONS

MNA	Mini Nutritional Assessment
CHD	Coronary heart disease
BMI	Body mass index
NHANES	National Health and Nutrition Examination Survey
NDNS	National Diet and Nutrition Survey
OR	Odds ratio

CHAPTER 1: INTRODUCTION

Malnutrition contributes to unhealthy aging through a variety of detrimental effects.[1] Because malnourishment (undernutrition) can be masked by changes commonly seen in aging, it may remain undiagnosed, resulting in physical and emotional consequences for the individual and unnecessary strain to health care resources.[2]

Tooth loss plays a role in dietary intake,[3] although the impact is still undetermined. Recognizing that this role may be significant, the oral healthcare professions strive to maintain the integrity of the dentition including improved dietary intake through dietary counseling. Counseling is advocated specifically for those individuals who are perceived to be at highest risk due to lack of oral integrity, the edentulous patient.[4,5,6]

1.1 Research Objectives

The objectives of this study were: a) to determine the prevalence of malnutrition and the comparative risk for malnutrition among orally compromised and orally functional subjects b) to identify and quantify risk variables, particularly oral variables, associated with malnutrition c) to identify the determinants and risk variables of dietary intake for the development of a conceptual model to better visualize where and how the oral/dental complex fits into this model d) to test the reliability of a nutritional screening instrument, the Mini Nutritional Assessment, within a population of community-living older adults who present for dental treatment.

1.2 Rationale for Conducting Research

The prevalence of malnutrition and risk of malnutrition among independently living elderly Manitobans is not known but is likely to be similar to that of other jurisdictions.[7,8] Although few studies have quantified risk according to dental status, many studies have concluded that risk for malnutrition increases with tooth loss, with fully edentulous individuals at greatest risk for malnutrition.[9,10,11] Dietary treatment within dentistry has therefore focused on advocating dietary counseling for edentulous patients.[12,13]

Edentulous individuals are disadvantaged to some nutrients[14,15] although their disadvantage may not be due solely to loss of teeth. A new conceptual model that illustrates determinants and risk variables for dietary intake, may help to expand the present dental model[16] which may be too restrictive.

If oral/dental risk variables significantly associated with dietary intake could be identified and quantified, they could be incorporated into existing screening tools and utilized by dental practitioners who routinely provide oral health care to community-living, well elderly. Such screenings could result in early diagnosis and treatment of malnutrition and have the greatest potential for successful outcomes.[17,18]

CHAPTER 2: BACKGROUND AND RELEVANT LITERATURE

2.1 Nutritional Status

2.1.1 Malnutrition

For this study, malnutrition means undernutrition in protein, calories, and micronutrients.[19] The rate of malnutrition has been reported as 1 - 15% in community-living healthy elderly persons.[20,21,22,17,23,24] The rate of community-living elderly who are at risk for malnutrition has been reported as 21.6 - 43%.[7,8,25,24]

Malnutrition from inadequate food intake is termed "primary malnutrition", whereas "secondary malnutrition occurs when physiologic factors such as digestion or absorption interfere with proper nutrient utilization.[19] In developed countries, inadequate food intake is primarily due to illness.[22]

The proportion of those aged >80 years is expected to increase by 43% in the next 10 years with 93% of Canadian seniors aged ≥65 years living at home but with a number of medical conditions.[26] Increased medical conditions result in increased use of medications that can decrease appetite and absorption of nutrients and frequently cause xerostomia or dry mouth.[27] Social isolation can lead to depression, which may also result in decreased appetite. Meals may be missed due to cognitive change while functional disabilities may limit food acquisition and preparation. Older adults may have a limited income thus limiting food quantity or quality.[27] Poor dental/oral health with resultant painful chewing not only increases risk for malnutrition[28] but also contributes to embarrassment and avoidance of social interaction.[29]

Diet is a modifiable risk factor common to many chronic diseases[30] with growing evidence that some non-communicable chronic diseases, including Type 2 diabetes are associated with a 'Western diet',[31,32,33] a diet of high-fat red meat and meat products, sugar and sweets, high-fat dairy products, and refined grains. This contrasts a "prudent diet", characterized by a higher intake of fruits, vegetables, legumes, fish, poultry, and whole grains.[34,35,36] A prudent diet with favorable dietary fatty acid composition[37,38] and increased fruit and vegetable consumption also has been reported to offer the best chance for a reduced risk of coronary heart disease (CHD) and stroke. [39,40,41] Studies identifying relative risk factors for the development of cancer of the lung, colon, cervix, esophagus, oral cavity, stomach, bladder, pancreas, and ovary have reported significant protective effects of fruit and vegetable consumption.[42,43, 44] The maintenance of a functional dentition has an important role in the consumption of a healthy dietary intake, a satisfactory nutritional status, and an acceptable body mass index.[45]

2.1.2 Indicators of Nutritional Status

Several clinical indicators of nutrition are used to measure nutritional status including body weight and body mass index; protein status (visceral protein stores such as albumin); vitamin levels and indirect measures of vitamin status (hemoglobin); and composite nutritional indices.[16]

2.1.2.1 Body Weight and Body Mass Index (BMI)

Characteristics of aging, including decreased appetite, changes in satiation, and muscle wasting may be viewed as normal even when accompanied by insidious weight loss. With subtle weight loss, diagnosis of malnutrition may be missed due to assumptions that symptoms are all due to increasing age.[2] Clinically, malnutrition is an involuntary weight loss of more than 5% within a month or 10% loss over 6 months.[46] Involuntary loss of 4% body weight over 4 years[47] or 5% or more over a three-year period[48] is associated with an increased risk of mortality. A low body mass in old age is associated with an increased risk of morbidity and mortality.[1] Body Mass Index (BMI) is a measure that was developed to eliminate the confounding effects of height on weight and is determined by dividing weight by the square of the height. A person with a low BMI (<18.5) is underweight for his/her height.[19] Body weight and the BMI are indirect measures of protein, fat, and carbohydrate stores or of energy malnutrition.

2.1.2.2 Protein Status

During illness or low dietary intake, protein provides energy that would normally be supplied by fats or carbohydrates.[1] The most widely used measures of nutritional state are nitrogen balance and secretory protein concentrations.[49] Serum hepatic protein levels of albumin, transferrin, and prealbumin correlate with morbidity and mortality and are therefore indicators of severity of illness.[50] Anthropometrical measurements such as mid-arm and mid-leg circumference are used as clinical indicators of protein malnutrition.[51]

2.1.2.3 Vitamins, Minerals, and Trace Elements

Biochemical measurement of levels of vitamins, minerals, and trace elements is able to demonstrate specific deficiencies associated with disease and to assess long-term nutritional support. These measurements are used to confirm diagnosis.[1]

2.1.2.4 Composite Indices

These are instruments that utilize risk indicators and risk markers for inadequate dietary intake, anthropometrical measures, and consumption of specific food groups to determine nutritional status. The Mini Nutritional Assessment (MNA)[52] was used in this study for determining nutritional status. Other screening tools are 'Malnutrition Universal Screening Tool' (MUST) and Malnutrition Screening Tool (MSN).[28]

2.2 Relationship of Dental Status to Diet

There are three major themes in the literature that address the relationship between tooth loss and diet: a) the pattern of food selection is altered with loss of teeth either as a result of an individual's inability to chew or an altered perception of his/her ability to chew b) following loss of teeth, patients require restoration for masticatory capability c) the relationship of masticatory function to dietary intake must account for and control the influence of potential confounding variables.

2.2.1 Theme 1: Patterns of Food Selection

A functional dentition is measured by masticatory performance and is associated with the number of functional tooth units.[53,54] The World Health Organization's definition of a functional dentition is the presence of 20 well-distributed teeth and 3 functional posterior pairs.[55,56,57,58,59,60,61] People with this configuration have satisfactory chewing ability with minimal adverse changes in food selection.[62]

Altered food selection pattern has been termed a "dose-related effect of diminished food choice" following loss of opposing posterior teeth.[63] Alterations to food selection and chewing performance occur progressively for people who report altered perceptions of ability [3,64,65] especially as the degree of impairment increases.[14] Complete tooth loss frequently results in restrictions to food choices that compromise nutritional status, such as a lower consumption of foods that are difficult to chew and increased consumption of foods that are easier to chew.[5,14,15,45,64,66,67,68,69,70]

Four large cross-sectional studies have investigated the relationship between oral/dental status and diet. Two studies examined self-reported nutrient intake (United States,1986, n=50,000 males[15], United States, 1998, n=1,231 males[71]). Intakes of fiber and most vitamins and minerals decreased as teeth were lost. The earlier study found that mean intakes of calories, saturated fats, and cholesterol increased as the numbers of teeth decreased whereas the more recent study found that calorie-adjusted intakes decreased with progressively impaired dentition status.

The other two large studies, United States National Health and Nutrition Examination Survey, NHANES III (1988-94, n=3794 healthy people aged 25 and over)[70], and British National Diet and Nutrition Survey (NDNS, 1998, n=881 people 65 years and older),[68] examined the relationship between dental status, dietary intake, and nutritional status as measured by key micronutrients. Dietary fiber intake was less among edentulous subjects. The American study found that Vitamin C, folate and beta-carotene (Vitamin A) were significantly lower for edentulous subjects compared to those with natural teeth (even after adjusting for social and behavioral factors such as tobacco use and use of vitamin and mineral supplements). The British study found plasma ascorbate (Vitamin C) and plasma retinol (Vitamin A) significantly associated with dental status.

Although the findings are contradictory for caloric intake for edentulous subjects, the findings of decreased fiber intake and significantly lower Vitamins A and C are an indication that some relationship exists between dental status and food intake.

2.2.2 Theme 2: Influences of Prostheses and Dietary Counseling on Dietary Intake

Once teeth are lost, individuals seek dental treatment to restore esthetics and function. A new dental prosthesis is provided to improve ease of chewing, oral comfort and quality of life.[72] However, there is lack of evidence that removable prostheses significantly improve dietary intake.[6,14,73,74] The improvement of chewing efficacy alone as a result of restoration with an optimal removable prosthesis does not necessarily result in improved food selection, and indeed, a

preference for foods with softer texture has been observed.[6,9,10,11,75,76,77,78,79] When complete denture quality to masticatory performance, perceived ability to chew, and diet quality was examined, it was found that there was no relation of the diet quality to the other variables.[80]

A randomized controlled trial[75] compared pre- and post-dietary intake for patients who received fixed partial dentures supported by implants to dietary intake for patients who received only removable partial dentures. No significant differences were observed between the two groups.

A more recent randomized controlled trial[78]compared dietary intake between patients receiving conventional removable partial dentures and those receiving bilateral resin-bonded fixed bridges. Neither method of rehabilitation resulted in change, with intake of fiber, fruits, and vegetables found to be low in both groups.

Dental implants have become an accepted modality of treatment. A consensus statement has advocated the use of two implants with a mandibular overdenture as the standard of care for an individual with an edentulous mandible.[81] Even with the use of implants, there is still minimal evidence of improved nutritional status following restoration. A Canadian study[82] randomized subjects to restoration with two implant-retained mandibular overdentures or conventional complete dentures with neither group receiving nutritional counseling. The implant group demonstrated significantly higher concentrations of serum albumin, hemoglobin, and B12 six months after treatment compared to the conventional denture group. In contrast, an American study[13,83] that used dietary logs to compare consumption of difficult to eat foods among patients

randomized to the same treatments as the Canadian study, reported that after 7 months of adaptation, patients consumed fewer difficult to chew foods than at baseline, particularly among patients restored with the implant-supported overdentures. Similarly, an Irish study[79] comparing the eating habits of patients restored with implant retained prostheses found that, although the comfort and ability to chew hard foods improved, 30% of subjects still avoided eating hard fruits and vegetables.

The prevalence of edentulism is decreasing,[84] however, because older people form a greater proportion of the population, the magnitude of people who will be orally compromised will be substantial. The major risk determinant for being edentulous is age[85], most likely as a result of the cumulative effects of dental disease. Additional risk variables are: increased age cohort[86], lower levels of education, income, and ethnicity.[85,87,88,89] The prevalence of edentulism in Canada was reported to be 17% in 1990[90], with 61% of the population partially edentulous.[91,92] The prevalence of total or partial edentulism increases after age 65 years.[85,93]

World wide, the proportion of older people is growing faster than any other age group, and is expected to triple from 2004 to 2050.[94] The proportion of the Canadian population over 65 years is 13.1%[95] and is expected to double by 2016 and triple by 2041.[86] This same trend is anticipated in Manitoba.[96] If and when dietary intake is compromised within this cohort, the importance of this demographic trend is the challenge that it will pose to healthcare and social

policy planners. Chronic diseases associated with aging will become the leading cause of disability and mortality.[97]

A solution to the problem that dietary intake does not improve subsequent to prosthetic rehabilitation of the compromised dentition is dietary counseling. Provision of counseling is advocated prior to, during, and following fabrication of conventional dentures or implant-supported prostheses[5,12,13,79,98,99] and relining of conventional dentures. Olivier et al [4] examined the diet of women aged 55 - 74 who received dietary counseling at the time their dentures were relined. The women responded positively to the counseling, evidenced by a self-reported increase in consumption of foods that had been avoided prior to restoration as well as an increase in fiber intake.

2.2.3 Theme 3: Confounding Variables in Relation to Masticatory Function and Dietary Intake

Although many researchers have ascribed a relationship between loss of teeth and diminished quality of dietary intake, other researchers have stated that associations between masticatory function and dietary intake are often based on relatively weak correlations.[98] Therefore, a causal relationship cannot be assigned to tooth loss and dietary intake. Associations may be observed because individuals who lose teeth may have confounding high-risk health behaviours, including less emphasis on diet.[98]

The inconsistency among findings suggests that dental status is one variable for dietary intake among other potential explanatory variables.

2.3 Determinants of Dietary Intake

Because many other potential explanatory variables of dietary intake are identified in the literature, another objective of this study was to develop a conceptual model for dietary intake. The model would assist in assessing the role of the oral/dental complex on dietary intake and, where possible, to quantify the effects of other variables on final outcome or dietary intake.

Food selection is directly related to the intake of energy and nutrients, however the ability to predict individual dietary intake is low because the process of food procurement, selection and subsequent nourishment is extremely complex.[100]

Healthy eating is dependent upon the 1) physical environment, 2) psycho-social environment and 3) an individual's situational determinants.[100] The physical environment limits food choice: availability of food is affected by the productivity of the agriculture sector, geography, weather, transportation, distribution, and affordable access to food.[100] Additionally, healthy eating depends on an individual's household characteristics including availability of time, food making equipment and storage as well as knowledge regarding food acquisition, transportation, and preparation.[101,102] Marketing measures are also known to modify an individual's choices.[103]

Psychological and sociological components of behaviour interact due to the nature of learning from social role models.[103] The social aspect of the framework implies a sense of community or gathering for the purpose of sharing meals.[103] Underlying determinants of culture include ethnicity and religious norms; family,

since it is within the family that eating practices are learned; the level of social support; and health ideals. Health ideals are the expectations, standards, hopes and beliefs that provide points of reference and comparison by which people judge and evaluate food choices that are seen to influence health.[102]

Individual[26] or situational determinants[103] include, among many other factors, age and sex. Among the elderly, loneliness, social isolation, and marital status contribute to decreased food intake.[104] Depression among the elderly, is often associated with loss or deterioration of social networks and can result in significant loss of appetite.[104] Illness and its associated symptoms influence dietary intake,[1] as does salivary availability. [22,26]

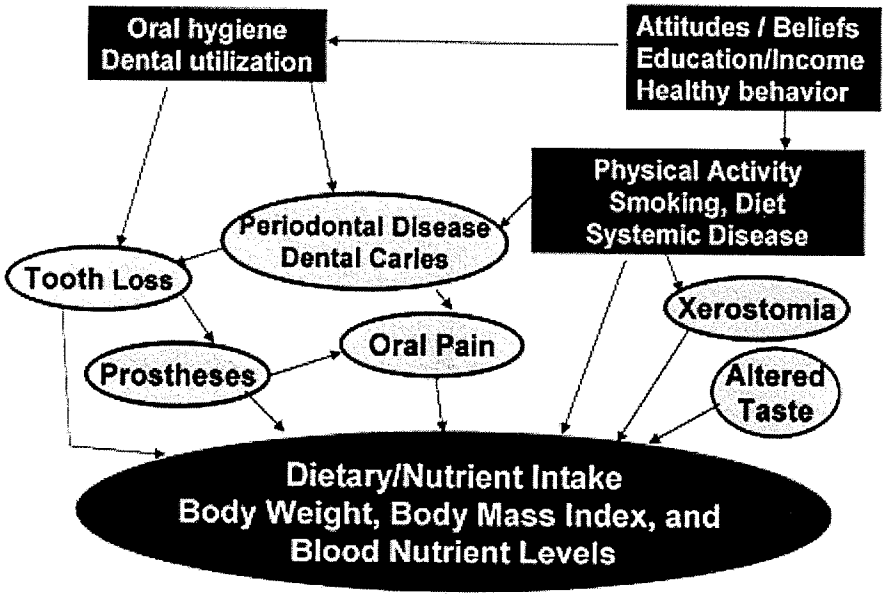
Saliva is important in the chewing process since it binds food together as a coherent bolus that can be swallowed safely without aspiration.[105] Insufficient saliva resulting in decreased chewing comfort is due to food sticking to the mucosa rather than together. Saliva is also important for denture retention and stability.[106]

Since saliva contains enzymes that dissolve the molecules needed in taste perception,[105] oral dissatisfaction in people with dry mouths has been shown to be due to altered taste.[107] "Anorexia of aging" is associated with impaired taste and smell that influence food choice.[108] There is reduction of the unstimulated salivary flow rate with age[109], but this does not appear to hold true for functional or stimulated flow rate[110]. Hydration is an important factor for regulating salivary flow.[111] Older people suffer from multiple diseases with accompanying use of multiple medications. Polypharmacy is one of the main causes of xerostomia.[105]

2.4 Conceptual Model of Determinants with Variables that Influence Dietary Intake

Most of the work that has been published regarding dietary intake and dentistry has utilized a model similar to that of Ritchie et al, Figure 2.1.[16] The model demonstrates that oral disease leads to tooth loss and ultimately to limitations in food selection. Similarly, pain, xerostomia, and altered taste contribute to deleterious dietary changes. Although the Ritchie et al model acknowledges the potential confounding influences of other behaviours, health habits, attitudes, and health status, the authors recognize that it is not possible to determine the unique influence on nutrition of any given variable.[16]

Figure 2.1 Oral/Dietary Intake relationship Ritchie et al [16]



CHAPTER 3: HYPOTHESIS AND RESEARCH METHODS

3.1 Hypothesis

The hypothesis of this study is that there is a higher prevalence of risk of malnutrition among subjects who are orally compromised compared to orally functional subjects. Orally functional individuals are defined as those subjects with ≥20 well distributed teeth, including ≥3 posterior occluding pairs.

3. 2 Study Methods

3.2.1 Study Design

This is a cross-sectional, epidemiologic, cluster sampling study with convenience sampling. The author was the sole investigator and administered two survey instruments to each subject.

3.2.2 The Population

The subjects were community-living (independent) people born in 1940 or earlier and attending the Faculty of Dentistry's Undergraduate Clinic at the University of Manitoba.

3.2.3 Subject Sample and Recruitment

Subjects who attended the clinic between September 7 and November 3, 2005 were considered for inclusion in the study if they were born in 1940 or earlier, displayed evidence of being conversational in English, could stand independently (for measuring their weight), and could provide written informed consent.

Prior to each clinical session, a list of patients including their date of birth and the name of assigned students was computer generated. The researcher (who is also a clinical instructor) approached those students whose patients met the study's age criteria to determine whether their patients were potential recruits. Patients were recruited to the study if student time commitments required for active patient care would allow approximately 15 minutes for collection of the study's data. If so, the researcher obtained patient informed consent, and conducted the interview. The researcher examined the subject to quantify the number of teeth and occluding pairs of posterior teeth.

During sessions when more subjects were available than could be examined, subjects were triaged based on whether or not their regular care required subsequent appointments.

3.2.4 Sample Size

Sample size determination was based on the formula for the comparison of two proportions of unequal group size[112], assuming there would be more subjects who were orally compromised.

In a similar patient population, orally compromised patients constituted 68.5% of the population. Individuals aged ≥65 years with a complete denture in one or two arches formed 56.1% of the population. Individuals with partial dentures in both arches formed 12.4%[91] of the population. Others have reported that 37.6% of those aged ≥65 years were edentulous, with an average of 20.5 retained teeth among the dentate elderly.[113] 68% (62.4%/2 (100 - 37.6) or 31.2%) were estimated as orally compromised.

Taking into account the declining prevalence of edentulism, the percentage of orally compromised among the current study population was further estimated at 60%. The ratio of groups in the final sample was based on this information.

The risk of malnutrition in community-living, older adults has been reported as 21.6 – 43%. Therefore the risk of malnutrition within the orally compromised group in the current study was assigned at an approximate mean of 30 percent. Risk of malnutrition within the functional group was set at 10 percent to reflect the "dose-related" response of oral compromise reported in the literature.

$$\mathbf{n\ (smaller\ group)\ =\ (2.5/1.5)\ x\ 2.48^2\ x\ \{(22\ x\ 78)/(30-10)^2\}}$$

The sample size required for 80% power of detecting such a difference using a standard one-tailed test of significance at the critical level of p = 0.05 level was 110 individuals (44 in the functional group, 66 in the compromised group). Sample size required to detect a 95% power of detecting such a difference was 195 individuals (78 in the functional group, 117 in the compromised group).

3.3 Ethical Considerations

3.3.1 Approval

Approval for conducting this research was received from the University of Manitoba Heath Research Ethics Board on August 27, 2005 (Appendix A), from the Faculty of Dentistry July 4, 2005 (Appendix B), and permission to copy the Mini Nutritional Assessment was received from Nestles International on July 13, 2005. (Appendix C)

3.4 Instruments

Two instruments were used for this study, the "Mini Nutritional Assessment" (MNA) and the test instrument, "Satisfaction With Oral Condition Questionnaire".

3.4.1 Mini Nutritional Assessment

The MNA (Appendix D) is an 18-question instrument used in medical settings, particularly institutional settings to assess nutritional status of older adults. The MNA was chosen for the current study because it had been validated previously, is currently utilized for nutritional screening in Manitoba at institutions such as Deer Lodge and its use has been acknowledged in the dental literature.

The MNA is referred to in the dental literature [16,24] as a screening tool for research, however, its use in dental practice as a diagnostic tool has not been reported.

The 18 items on the MNA are comprised of anthropometrical measurements (body mass index, mid-arm and calf circumference, and weight loss), questions regarding dietary intake (number of meals consumed, food and fluid intake, and feeding autonomy), a global assessment (lifestyle, medication, mobility, presence of acute stress, and presence of dementia or depression), and a self-assessment of health and nutritional status.

The MNA is a two-part screening instrument. The first part contains six questions. If, based on the patient's response to the first six questions, s/he was deemed "not at risk", then the next 12 questions would not be completed. When the first part of the screening indicated potential malnutrition, then the second set of questions would be asked.

The goal of the MNA is to identify risk of malnutrition to permit early nutritional intervention.[20] A score of ≥24 identifies 'no nutritional risk', a score of 17-23.5 indicates 'nutritional risk', and a score < 17 indicates 'malnutrition'.

The MNA has been validated in three studies involving more than 600 elderly from the very frail to the very active in free-living and long-term care environments. The tool was validated against a clinical evaluation and a comprehensive nutritional assessment.[114] Sensitivity of the MNA has been reported to be 96%, specificity reported to be 98%, and a predictive value reported to be 97% when compared to anthropometric, clinical biochemistry, and dietary parameters.[52]

3.4.2 Satisfaction With Oral Condition Questionnaire

For the purposes of this study, a questionnaire was developed to assess whether examined risk variables were associated with malnutrition. As this is considered a preliminary study, the tool in its entirety was not validated previously.

3.4.2.1 Rationale for Questions

The instrument gathered additional demographic information to compare the study population with the Manitoban and Canadian populations and was used to determine the strength of association between these variables and risk of malnutrition.

The following questions were included to profile the sample population to compare it to the Manitoban and Canadian populations.

✓ **Level of education** People with low educational levels are at increased risk for consumption of meals that are not balanced [115]

✓ **Numbers of times/week that the subject engages in physical activities**

✓ **Did you ever smoke tobacco? Do you still? How much?**

The following questions were included to determine if an association exists between the variable and risk of malnutrition.

► **Area where subject grew up**

►**Numbers of times/week that the subject engages in social activities.**

►**Do you have a hearing aid? Do you use it regularly?**

►**Do you live by yourself?** People who live alone are at higher risk [115,116,117,118] for malnutrition and chronic systemic diseases exacerbated by poor dietary habits.

►**How many prescription medicines do you take?** This is an expansion of the question in the MNA assessing numbers of medications. Polypharmacy is one of the main causes of xerostomia.

The following questions were included to determine if an association exists between the variable and risk of malnutrition and to determine if an association exists between oral status, the variable and risk of malnutrition.

✳ **Are you satisfied with your overall oral condition?**

✳ **Are you satisfied with your ability to bite?**

✳ **Are you satisfied with your ability to chew?**

✳ **Are you satisfied with the appearance of your teeth?**

✳ **Are you satisfied with your speech?**

✳ **Does your mouth feel dry most of the time?**

✳ **If you have lost three or more teeth, did you feel that losing these teeth affected the foods you chose to eat?**

The remaining data entry fields on the instrument were used to determine dental status, including numbers of remaining anterior and posterior teeth and numbers of functioning occluding pairs.

3.5 Data Entry, Storage, and Analysis

3.5.1 Data Entry

The MNA data was coded 0 - 3 with 0 least favorable, except for protein consumption where higher risk was represented by "1" and lower risk by "0".

The Satisfaction with Oral Condition Questionnaire coded "0" to indicate lower risk status. Where questions resulted in continuous data, the actual number was entered.

3.5.2 Data Storage

A master patient list was used to retain subject names, Faculty of Dentistry chart numbers, and to generate subject numbers. Patient identifiers were removed, labeled with the subject number, and secured in the researcher's office.

3.5.3 Analysis Strategy

Nutritional status was determined from the MNA. The association between nutritional status and risk variables from the Satisfaction with Oral Condition Questionnaire was then determined by cross-tabulation analysis.

The original data was entered by the researcher into Excel software program and then converted to Statistical Package, SPSS 14 to compute statistical analysis. The plan of analysis was to a) describe the population b) test for association between independent and dependent variables using chi-squared tests for categorical data and t tests for continuous data and c) use logistic regression to identify those risk variables uniquely associated with malnutrition from statistically significant variables identified with univariate tests.

The dependent variable is 'at risk of malnutrition'. Testing for significance of categorical variables that were not normally distributed, obtained from the Satisfaction with Oral Condition Questionnaire was done using a chi-squared test. The assumption for null hypothesis is that all groups would demonstrate equal rates of risk. Strength of associations between the dependent variable and the independent variables determined the risk variables.

The significance level used was p value of 0.05 or a 5% chance that the observed difference could arise by chance if the null hypothesis of no relationship is true.[112] Yates or continuity correction[112] is used when there are only two categories (only one degree of freedom) because when there is only one degree of freedom, the chi-squared test can overestimate the differences between

expected and observed results because the observed results must be discrete whole numbers and cannot exactly match the expected values.

Testing for significance for continuous or normally distributed variables obtained from the Satisfaction with Oral Condition Questionnaire was performed using t tests. The t test compares the actual difference between two means in relation to the variation in the data.[112] The continuous variables were: age, number of physical activities/week, number of social activities/week, number of prescribed medications, and number of packages of cigarettes smoked/week.

Logistic regression was used to analyze this data because the dependent variable is binary and the independent variables are a mixture of both categorical and continuous measurements.

Regression analysis is a sophisticated statistical method used to determine the influence on an outcome variable (in this case, malnutrition) that is uniquely attributed to one, or several, explanatory variables. In this way, the significance of the impact on the dependent variable of the independent variable can be determined and the nature of the impact quantified.[112] Once the key independent variables are determined, a predictive risk variable/ risk of malnutrition model can be developed.

When the outcome variable is binary (Risk of malnutrition, Yes/No), as was the case in this study, logistic regression must be utilized. Logistic regression quantifies the impact of an explanatory variable on the risk of the outcome occurring in the form of an odds ratio (OR) that measures the change in the odds of this outcome occurring following a one unit change in the independent

variable. In addition, it ensures that this odds ratio is adjusted for the influence of other risk variables in the regression model and that it provides a measure of the unique influences of the risk variable on the outcome.

CHAPTER 4: RESULTS

4.1 Overview of the Data

Data were screened for outliers in range of values (coding) as well as for missing values (Appendix F). It appeared that data was missing for five subjects for the question regarding food choice change following loss of teeth, however, these subjects had complete dentitions and had no experience of tooth loss. One subject had a complete dentition, however, due to his occlusion had only two functional occluding pairs causing this entry to appear erroneous under 'dental status'.

The total number of people interviewed was 174 with one subject requesting withdrawal. The final number of subjects was 173.

4.2 Overview of the Results

Results of the study population are summarized in Table 4.1. Summaries of the results from the Satisfaction with Oral Condition Questionnaire are presented in Tables 4.7 and 4.8 while summary of the results from the Mini Nutritional Assessment is provided in Table 4.12. The variables from the Satisfaction with Oral Condition instrument were tested against risk of malnutrition to explore univariate associations between these independent variables and the risk of malnutrition. A forward stepwise logistic regression was then utilized to develop an optimal model relating patient demographics and patient characteristics from the Satisfaction with Oral Condition Questionnaire to risk of malnutrition and to identify those risk variables that made a significant unique contribution to a patient's odds of being at risk of malnutrition.

4.3 Results

4.3.1 Prevalence Of Malnutrition

The actual number of subject responses collected was 173, 94 in the functional group and 79 in the compromised group. No subjects in the sample population were malnourished. Prevalence of risk of malnutrition was 11.6% (20/173) with prevalence for subjects orally compromised, 13.9% (11/173), and subjects orally functional, 9.6% (9/173).

4.3.1.1 Summary Of The Sample Population (Appendix F)

Table 4.1 provides a summary of the sample population.

4.3.1.2 Sample compared to Canadian and/or Manitoban populations

Tables 4.2 - 4.6 demonstrate the findings of the sample population compared to census data by sex, highest educational level attained, weekly physical activity, and reported depression over the last 3 months. This study has a male proportion that is substantially higher than the Canadian and Manitoban male norms ($p<.001$), displays a much higher education level ($p<.001$), is more active and less likely to report to smoke than the national or provincial levels. This population reported a higher rate of depression than the national level, although comparison census data was 10 years old. 80% of the subjects reported that they felt 'as healthy or healthier than their peers'.

Table 4.1 Summary of Sample Population

Variable	*Percentage*	*Mean*	*Range*
Age		72.98	64-92
Sex	54.9 Male		
	45.1 Female		
Reduced food intake	13.9		0 - severe
Weight loss in last three months	23.15		0 - > 3 kg
Stress or acute disease in last three months	16.2		Y/N
Depression/dementia	21.9		Y/N
BMI		26.820	14.4 - 38.8
Taking more than 3 drugs/day	30.1		Y/N
Number of meals/day - 1	10.4		
- 2	42.2		
- 3	52.6		
At least one serving dairy product/day	92.5		
At least two servings legumes/eggs/wk	75.7		
At least one serving meat/fish/poultry/day	72.8		
Two or more servings fruit/veg/day	85.0		
Drinks 5 or more cups liquid/day	79.2		<3 - >5
Sees self as malnourished or uncertain of nutritional status	8.7		
Sees self as not as healthy or uncertain about health status as peers of age cohort	6.9		
Mid-arm circumference < 22 cm	2.9		
Mid-calf circumference < 31 cm	2.3		
Numbers of subjects below 23.5	11.6		
Level of education < high school	28.3		
Grew up in city or large town	52.0		
Physically active number of times /week		5.12	0 - 7
Socially active number of times/week		3.88	0 - 7
Have a hearing aid	17.3		
Of those who have a hearing aid, those who use it	61.3		
Live alone	28.5		
Number of prescription drugs/day	2.47	2.47	0 - 15
Satisfied with oral condition	79.8		
Satisfied with ability to bite	82.7		
Satisfied with ability to chew	83.8		
Satisfied with appearance	71.7		
Satisfied with speech	90.8		
Oral cavity dry most of the time	13.9		
Losing teeth has affected choice of foods	18.6		
Has smoked tobacco	54.3		
Still smokes tobacco	8.7		
Cigarette packs/week	0.76	0.76	1 - 14
Subjects orally functional	53.8		
Anterior teeth for functional		11.81	9 - 12
Posterior teeth for functional		12.8	8 - 20
Occluding pairs for functional		5.31	3 - 10
Subjects orally compromised	46.2		
Anterior teeth for compromised		6.91	0 - 12
Posterior teeth for compromised		4.71	0 - 15
Occluding pairs for compromised		0.81	0 - 5

Table 4.2

Proportion of population by sex aged 65 and over

Sex	Canadian [119] (2005)	Manitoba (2005)	Present Study
Males	43.4	42.7	54.9
Females	56.6	57.3	45.1

Chi squared goodness of fit (Sample v. Manitoba) = 10.54, 1 df, $p<0.001$

Table 4. 3

Population in % by high school, trades, university as highest level of schooling

Canadian[120] (2001)	Manitoba (2001)	Present Study
44.8	40.1	71.7

Chi squared goodness of fit (Sample v. Manitoba) = 71.82, 1 df, $p<0.001$

Table 4.4

Physical activity by % for level of activity in people aged 65 and over

	Active (5-7x/week)	Moderately active (2-4x/week)	Inactive (0-1x/week)
Canadian average[121]	15	20	65
Present study	65.3	26	8.7

Table 4.5

Percentage of people aged 65 and over who smoke

Canadian population[122] (2001 census)	Manitoba (2001 census)	Present study
10.4	9.9	8.7

Table 4.6

Percentage of people aged 65 or over reporting depression for 5 - 11 weeks

Canadian population[123] (1996-97 census)	Manitoba	Present study
17	Not available	20.2

4.3.1.3 Summary of the 'At Risk Population' (Appendix G)

The mean age for the 'at risk' population was 76 years compared to the mean age of the sample population of 73 years. 55% of the 'at risk' population was female compared to 45% in the general sample population. Only 20% of the 'at risks' live alone whereas 28.5% live alone in the total sample population. None of the subjects in the 'at risk' population was totally edentulous.

4.3.2 Risk Variables Associated with Malnutrition

4.3.2.1 Risk Variables Identified following Univariate Analysis of Test Instrument 'Satisfaction with Oral Condition Questionnaire'

The MNA was used to sort subjects into 'at risk' and 'not at risk' categories. The variables in the Satisfaction With Oral Condition Questionnaire were tested on a univariate basis for strength of association to risk of malnutrition, resulting in eight risk variables being identified. Five of the eight risk variables were categorical and were reduced to binary data: dry mouth (yes or no), where grew up (rural/urban), satisfied with overall oral condition (yes or no), satisfied with ability to chew (yes or no), and satisfied with ability to speak (yes or no). The other three variables were continuous: age, frequency of physical activity, and number of prescription medications per day.

'Having a dry mouth most of the time' displayed the highest association with risk of malnutrition, ($p = <.0001$). Three other risk variables were also highly significant: 'where subject grew up', ($p = .004$), 'satisfaction with subject's ability to chew', ($p = .006$), and 'frequency of physical activity/ week', ($p = .008$). Four other risk variables are significant to a critical value less than $p = .05$: 'age', (p =

.01), 'satisfaction with ability to speak', (p = .019), 'number of prescription medications taken daily', (p = .026), and 'satisfaction with oral condition', (p = .033).

Tables 4.7 and 4.8 summarize the association of the risk variable to the risk of malnutrition. (Appendix H)

Table 4.7
T-test and probability values for continuous data from Satisfaction With Oral Condition Questionnaire

Questions from Satisfaction with Oral Condition instrument	Risk group Mean n=20	Not at risk Group Mean N=153	t Value	p
Age	72.58	76.00	-2.621	.01
Physical activities/week	3.85	5.29	-2.665	.008
Social activities/week	3.00	4.00	-1.886	NS (.061)
Prescription medications	3.55	2.33	-2.239	.026
Number of packs/week	0.63	0.24	-1.207	NS (.229)

Table 4.8
Chi squared and Goodness of fit between risk of malnutrition subjects and healthy subjects from Satisfaction With Oral Condition Questionnaire (Appendix G)

Oral Satisfaction risk variable		% At risk	% Not at risk	Chi-squared value	p
Sex	Male	45% (9/20)	56.2% (86/153)	.502	NS (.479)
	Female	55% (11/20)	43.8% (67/153)		
Highest level of education	<High school	30% (6/20)	28.1% (43/153)	.106	NS (.900)
	High school, > high school	70% (14/20)	71.9% (110/153)		
Where grew up	Rural	15% (3/20)	47.7% (73/153)	8.416	.004
	Urban	85% (17/20)	52.3% (80/153)		
Hearing aid use for those who own one	Use	66% (2/3)	59% (16/27)	0.062	NS (.804)
	Do not use	33% (1/3)	41% (15/27)		
Live alone	No	80% (16/20)	70.6% (108/153)	0.398	NS (.528)
	Yes	20% (4/20)	29.4% (49/153)		
Satisfied with oral condition	Yes	60% (12/20)	83% (127/153)	4.561	.033
	No	40% (8/20)	17% (26/153)		
Satisfied with ability to bite	Yes	70% (14/20)	85% (130/153)	1.868	NS (.172)
	No	30% (6/20)	15% (23/153)		
Satisfied with ability to chew	Yes	60% (12/20)	87% (133/153)	7.571	.006
	No	40% (8/20)	13% (20/153)		
Satisfied with appearance of teeth	Yes	55% (11/20)	74.5% (114/153)	2.456	NS (.117)
	No	45% (9/20)	25.5% (39/153)		
Satisfied with speech	Yes	75% (15/20)	93.5% (143/153)	5.462	.019
	No	25% (5/20)	6.5% (10/153)		
Dry most of the time	No	50% (10/20)	91.5% (140/153)	22.953	<.0001
	Yes	50% (10/20)	8.5% (13/153)		
Losing teeth affected food choice	No	75% (15/20)	81.8% (121/148)	0.175	NS (.675)
	Yes	25% (5/20)	18.2% (27/148)		
Ever smoked	No	40% (8/20)	47.1% (72/153)	0.569	NS (.752)
	Yes	60% (12/20)	52.9% (81/153)		
Still smoking	No	80% (16/20)	93.5% (143/153)	2.691	NS .101
	Yes	20% (4/20)	6.5% (10/153)		
Oral status	Functional	45% (9/20)	54.9% (84/153)	0.356	NS (.551)
	Compromised	55% (11/20)	45.1% (69/153)		

4.3.2.2 Results following Logistic Regression (Appendix I)

Although eight variables were determined significantly associated with malnutrition, it was necessary to determine whether all eight were necessary to accurately describe or predict the level of risk of malnutrition of a specific individual, or whether a reduced set of these explanatory variables would be

equally effective. If several explanatory risk variables are effectively confounded with one another, then one of these could effectively represent, or stand in for, the other variables in a predictive relationship that would be smaller and simpler, while equally effective. It is important, however, to be aware that the risk variables incorporated into such a reduced model may represent the influence of other associated risk variables.

A reduced, or stepwise, regression model was developed through a series of forward iterations. In each step, the most predictive or highly associated risk variables, not yet in the model, was added. This stepwise process stopped when the most predictive variable remaining was not significantly associated with the outcome.

The nature of the relationship between the outcome and a predictor is expressed as an odds ratio, a statement of how the odds of being at risk of malnutrition vary per one unit change in the value of the variable after the possible influence of the other variables in the regression model have been controlled for or eliminated.

The variable entering the model on the first iteration, (Table 4.9) was 'presence or absence of dry mouth' ($p = <.0001$). Following the first iteration, once the independent variable "dry" was controlled for, the independent variables, 'number of medications' ($p=0.031$), 'satisfied with oral condition' ($p=0.020$), and 'speech' ($p=0.008$) were no longer significantly associated with the outcome since these are confounded with 'dry mouth'. After controlling for

'dry mouth', the variables 'rural' (p = .002), 'physical activity' (p = .002), and 'age' (p = .024) remained significantly associated with 'risk of malnutrition'.

The variable entering the model on the second iteration was 'where grew up' (p=.001). Physical activity was confounded with 'where grew up'. When both variables 'dry' and 'where grew up' were controlled for, 'age' remained the predictor significantly associated with 'risk of malnutrition' (p = 0.042). When age was entered into the model on the third iteration, one further predictor variable, 'satisfaction with ability to chew' became significant (p = .006), and entered on the final iteration, resulting in a potential four risk variable model. (Table 4.10, Appendix I)

Table 4.9

Significance of variables prior to forward logistic regression analysis

		Chi squared	df	Sig.
Step 0 Variables	education	.014	1	.907
	rural	10.210	1	.001
	physAct	6.189	1	.013
	socAct	3.271	1	.071
	hearingaid	.051	1	.822
	live_alone	.745	1	.388
	nmeds	4.667	1	.031
	satiscond	5.406	1	.020
	bite	2.528	1	.112
	chew	8.789	1	.003
	look	3.469	1	.063
	speech	7.131	1	.008
	dry	25.110	1	.000
	food_choic	.500	1	.480
	ever_smok	.163	1	.686
	oralstatu	.540	1	.463
	age	6.540	1	.011
	sx	1.052	1	.305
Overall Statistics		54.329	18	.000

Table 4.10
Significant Associations* between risk of malnutrition and potential risk variables

No Variables Controlled for	*Mouth Dry? Controlled for*	*Mouth Dry? Grew Up? Controlled for*	*Mouth Dry? Grew Up? Age? Controlled for*	*Mouth Dry? Grew Up? Age? Chew? Controlled for*
Mouth Dry? p<0.001	Grew Up? p=0.002	Age p=0.042	Chew? p=0.006	No Significant Associations
Grew Up? p=0.001	Physical Activity p=0.017			
Chew p=0.003	Age p=0.024			
Speech p=0.008				
Age p=0.011				
Physical Activity p=0.013				
Satiscond p=0.020				
No. of Meds p=0.031				

*SPSS, Logistic Regression

4.3.2.3 Results as Adjusted Odds Ratio

Due to differing age distribution in this population, adjustment was performed to determine the findings between risk of malnutrition and key risk variables as odds ratios.

Two variables related to oral status were quantified. These are 'having dry mouth' and 'not satisfied with ability to chew'. Subjects with dry mouth are 7.724 times more at risk and those who are not satisfied with their chewing ability are 5.868 times more at risk for malnutrition than those who are satisfied.

Risk increased with age by 1.158 times/year (15.8%) or 4.336 times/decade.

Subjects who grew up in an urban setting are at 7.937 greater risk for malnutrition than subjects who grew up in a rural setting. (Table 4.11)

Table 4.11
Relationship between risk of malnutrition and key risk variables

Log odds of risk of malnutrition = -15.338 + 2.044 Mouth Dry? + 2.075 Grew Up? + 0.146 Age + 1.770 Chewing Ability?

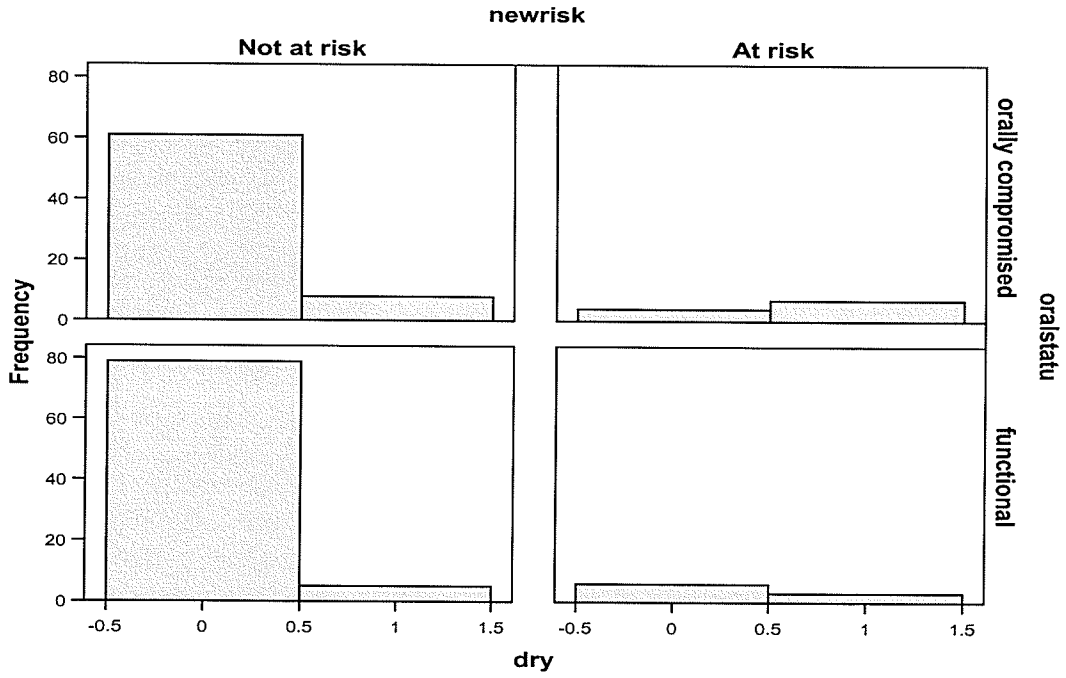
Variable	Values	Slope	Chi squared	Prob.	Adjusted Odds Ratio
Mouth Dry?	0 No 1 Yes	+ 2.044	11.831	0.001	7.724 (Yes/No)
Grew Up? (Urban/Rural)	0 Rural 1 Urban	+ 2.075	11.639	0.001	7.937
Age	Years	+ 0.146	8.320	0.004	1.158/yr (4.336/decade)
Chewing Ability?	0 Satisfied 1 Not sat.	+ 1.770	7.126	0.008	5.868 (NS/S)

4.3.2.4 Strength of Association between Risk Variable, Dental Status, and Risk for Malnutrition

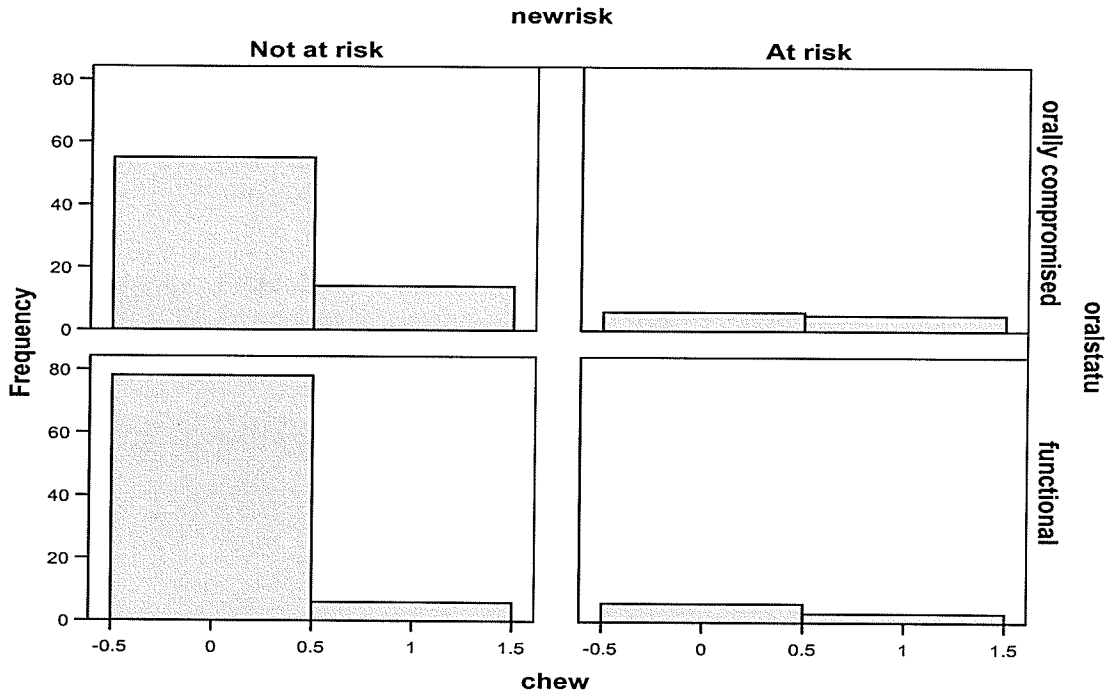
One of the objectives of the study was to identify and quantify risk variables associated with risk for malnutrition, with focus placed on dental status. Dental status was not determined to be a risk variable; however, because it is a focus in this study, the following histograms have been utilized to illustrate the strength of association between the risk variable and the risk of malnutrition among those who are orally functional and those who are orally compromised.

In Graph 4.4, it is especially noteworthy that there are no subjects in the orally compromised and the rural or 'not at risk' group.

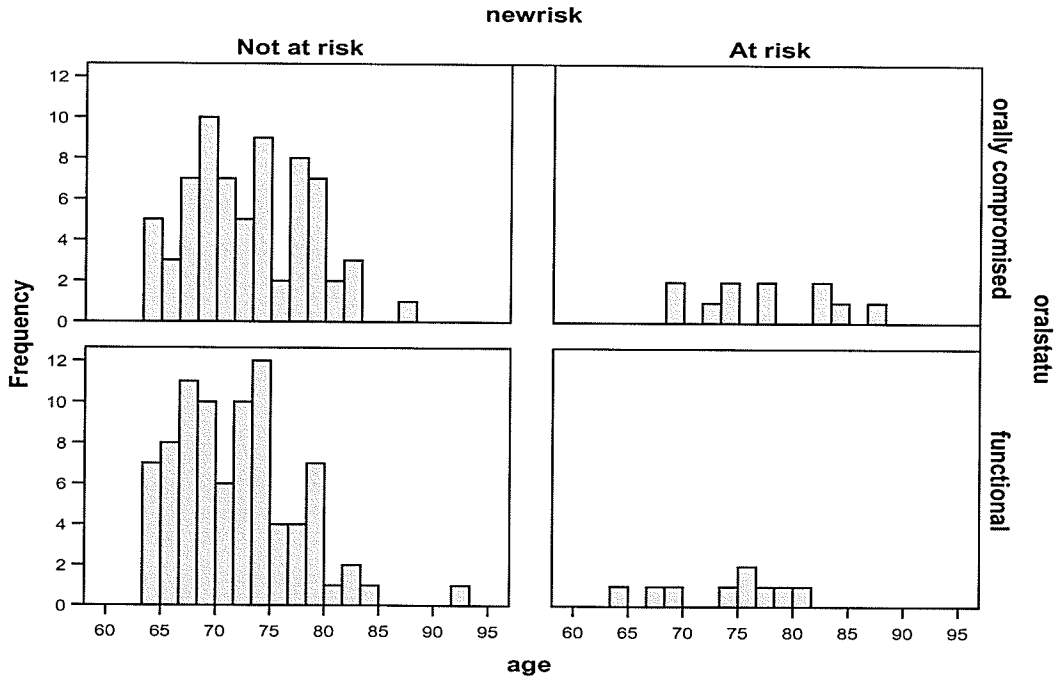
Graph 4.1 Dry mouth, risk of malnutrition, and oral status



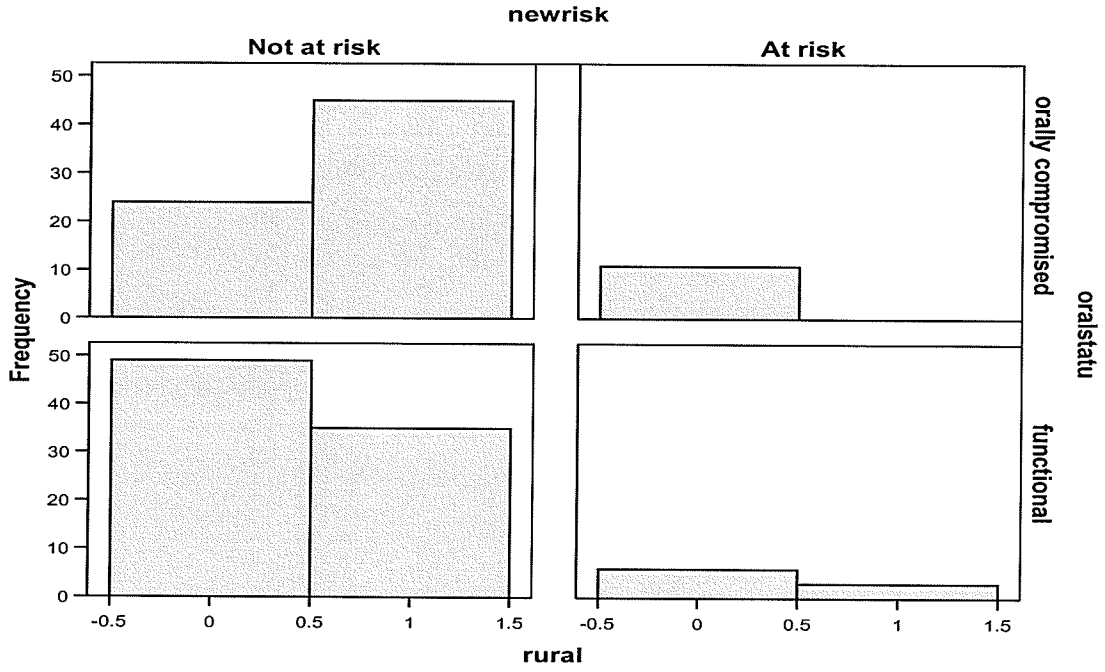
Graph 4.2
Satisfaction with ability to chew, risk of malnutrition, and oral status



Graph 4.3 Age, risk of malnutrition, and oral status



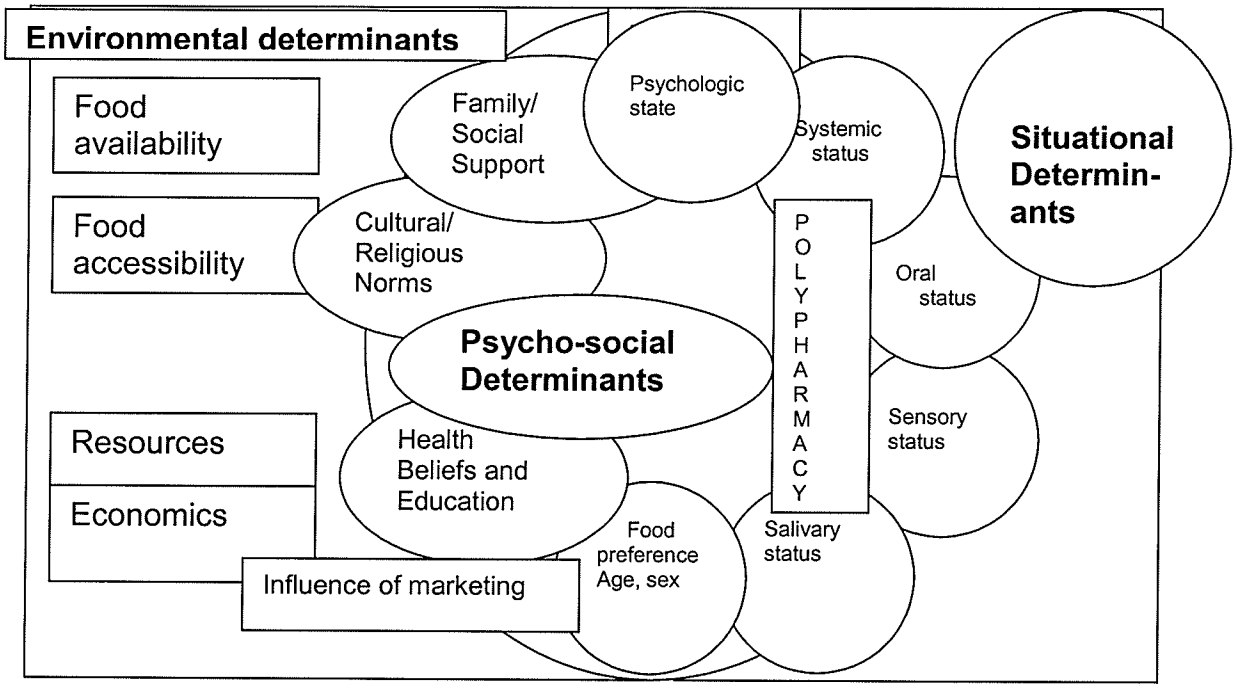
Graph 4.4 Where subject grew up, risk of malnutrition, and oral status



4.3.3 Conceptual Model

A conceptual model for dietary intake was developed to demonstrate the role of the oral/dental complex on dietary intake. Research on nutrition within dentistry has perhaps been challenged by the limitations imposed by assumptions that the mouth is the gatekeeper to the dietary intake process, rather than merely part of a much larger and very complex behavioural and physiological process. This conceptual framework was developed based on work by Canadian public health researchers, Payette et al[26], Raine[100], Popkin[101], and Furst et al[102] and Gedrich[103].

Figure 4.1 Conceptual Model: Determinants and variables that influence dietary intake



4.3.4 Assessment of MNA Screening Instrument

The final objective was to determine the use of this screening instrument in the dental office.

The summary of the results from the MNA includes a sensitivity analysis between the screening portion of the MNA and the complete MNA assessment score. The associations between the individual MNA variables and the MNA outcome, "risk for malnutrition", were examined to provide an insight into the detailed relationship between risk of malnutrition and patient characteristics and to assess the validity of the Mini Nutritional Assessment screening tool. The reliability of the MNA was assessed using Cronbach's Alpha[124].

The following table provides a summary of the results from the MNA. The cross-tabulations used to determine these results are included in Appendix J.

Table 4.12

Risk variables in relation to nutritional status from MNA (Appendix J)

MNA Variable		% At risk	% Not at risk	Chi-squared value	P value
Has food intake declined in last 3 months	Severe	15% (3/20)	0 (1/153)	56.519	<.001
	Moderate	50% (10/50)	7.2% (11/153)		
	No loss	35% (7/20)	92.8% (142/153)		
Weight loss during the last 3 months	>3 kg	30% (6/20)	3.3% (5/153)	43.830	<.001
	Uncertain	15% (3/20)	0.7% (1/153)		
	Loss 1-3 kg	25% (5/20)	13.1% (20/153)		
	No loss	30% (6/20)	80.3% (127/153)		
Has suffered psychological stress or acute disease in the past 3 months	Yes	60% (12/20)	10.5% (16/153)	28.456	<.001
	No	40% (8/20)	89.5% (137/153)		
Suffers neuropsychological problems	Severe	10% (2/20)	0.7% (1/153)	20.925	<.001
	Moderate	45% (9/20)	15% (23/153)		
	No	45% (9/20)	84.3% (129/153)		
Body mass index	< 19	15% (3/20)	0 (0/153)	26.532	<.001
	19 - <21	5% (1/20)	3.9% (6/153)		
	21 - <23	20% (4/20)	9.2% (14/153)		
	>23	60% (12/20)	86.9% (133/153)		
Takes more than 3 prescription drugs/day	Yes	65% (13/20)	25.5% (39/153)	11.322	.001
	No	35% (7/20)	74.5% (39/153)		
Pressure sores or skin ulcers	Yes	5% (1/20)	1.3% (2/153)	.078	NS (.780)
	No	95% (19/20)	98.7% (151/153)		
Number of full meals eaten daily	1	20% (4/20)	9.2% (14/153)	10.042	.007
	2	55% (11/20)	28.8% (44/153)		
	3	25% (5/20)	62.1% (95/153)		
Protein Intake	0,1 yes	20% (4/20)	10.5% (16/153)	5.297	NS (.071)
	2 yes	50% (10/20)	32.7% (50/153)		
	3 yes	30% (6/20)	56.9% (87/153)		
Dairy intake/day	0/day	15% (17/20)	6.5% (10/153)	.809	NS (.368)
	1+/day	85% (17/20)	93.5% (143/153)		
Legumes/eggs/week	<2/week	50% (10/20)	20.9% (32/153)	6.634	.01
	2+/week	50% (10/20)	79.1% (121/153)		
Meat/fish/proteins/day	Not daily	35% (13/20)	26.1% (40/153)	.325	NS (.569)
	Daily	65% (7/20)	73.9% (113/153)		
Consumes 2 or more fruits/vegetables/day	No	25% (5/20)	13.7% (21/153)	.988	NS (.320)
	Yes	75% (15/20)	86.3% (132/153)		
Fluid intake/day	<3 cups/day	5% (1/20)	2.6% (4/153)	1.222	NS (.543)
	3-5 cups/day	25% (5/20)	17.0% (26/153)		
	>5 cups/day	70% (14/20)	80.4% (123/153)		
Self-view of nutritional status	Malnourish	10% (2/20)	0 (0/153)	41.303	<.001
	Not certain	35% (7/20)	3.9% (61/153)		
	No problems	55% (11/20)	96.1% (147/153)		
Self-view of health status	Not as good	20% (4/20)	5.3% (8/153)	8.934	.011
	As good	45% (9/20)	31.4% (48/153)		
	Better	35% (7/20)	63.4% (97/153)		
Mid-arm circumference	< 21 cm	5% (1/20)	0 (0/153)	13.772	.001
	21,22 cm	10% (2/20)	1.3% (2/153)		
	>22 cm	85% (17/20)	98.7% (151/153)		
Mid-calf circumference	<31 cm	15% (3/20)	.7% (1/153)	10.392	.001
	31 or >31cm	85% (17/20)	99.3% (152/153)		

4.3.4.1 Associations to the Determined Nutritional Status Using MNA

All 173 subjects in this study were mobile, living independently, and able to feed themselves.

Strength of association p = <.0001

Three variables were significantly associated with risk of under nutrition with a significance less than p=.00001. These were: reduced food intake in the last 3 months, weight loss during the last 3 months, and self-view of nutritional status.

Strength of association p = <.001

Three variables resulted in statistical significance less than p=.001. These variables were: suffering psychological stress or acute disease in the last 3 months, suffering from neuropsychological problems, and BMI.

Strength of association p = .001 - <.01

Three variables were significant to p=.001: takes more than 3 prescription drugs daily, mid-arm circumference, and mid-calf circumference.

Number of full meals eaten daily variable was significant to .007.

Strength of association p = <.05

Intake of legumes and eggs (a subset of protein intake), (p=.01) and self-view of health status (p=.011) were significant at the p = .05 critical value.

Strength of association p = >.05

Six remaining variables did not demonstrate a statistically significant difference ($p \geq 05$) between the 'at risk' group and the 'not at risk' group: protein intake (a subset of protein intake) (p = .071), consumes 2 or more fruit/vegetables/day (p = .320), dairy intake/day (a subset of protein intake) (p = .368), fluid intake (p =

.543), meat/fish/protein intake/day (p = .569), and pressure sores (n= 3 for pressure sores identified in the study, p = .780).

4.3.4.2 Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value Of Screening Score to Total Screening Score

A full MNA assessment was completed for all 173 subjects. 10% (2/20 subjects) would not have been identified as being at risk of malnutrition by using the '6 question screening test' alone. In this population, all the individuals at risk would only have been determined if a score of 13 were used.

Table 4.13
Screening score from MNA and number 'at risk for malnutrition' and 'properly nourished'

		Status		Total
		At risk for malnutrition	Properly nourished	
Screening score	6.00	2	0	2
	7.00	2	0	2
	8.00	3	0	3
	9.00	3	1	4
	10.00	7	3	10
	11.00	1	11	12
	12.00	1	20	21
	13.00	1	41	42
	14.00	0	77	77
Total		20	153	173

Table 4.14
2x2 Table for MNA screening score to final assessment score

	At risk	Not at risk
Screening Portion Of MNA	Subjects identified "at risk" from screening portion and who are at risk. 18	Subjects identified "at risk" from screening portion and who are not at risk 15
Full MNA	Subjects not identified "at risk" from screening portion. 2	Subjects identified "not at risk" from screening portion and who are not at risk 138

Sensitivity of MNA screening in this study: 90% (18/(18 + 2))

Specificity of MNA screening in this study: 90.2% (138/(15+138)).

Accuracy of MNA screening in this study: 90.2%
(18 + 138/(18 + 138 + 2 + 15)).

Positive predictive value of the screening portion of the MNA in this study: 55%
(18/(18+15)).

Negative predictive value of MNA screening in this study: 98.6%
(138/(2 + 138)).

4.3.4.3 Reliability of MNA

Calculating Cronbach's Alpha for the instrument assessed the inter-item reliability of the MNA. The calculated value of 0.585 confirms that the MNA is a reliable instrument within the study population. However, the fact that a number of the scale items were not significantly associated with the scale outcome suggests that, at least in the context of this study group, reliability might be further improved by substituting these risk variables with others more highly associated for this population.

Chapter 5: Discussion

5.1 Prevalence of Malnutrition

The key objective of this research was to determine the prevalence of malnutrition in older community-living adults in Manitoba. Since none of the subjects in this study were found to be malnourished and only 11.6% were found to be at risk of malnutrition, while the prevalence reported in the literature is 1-15% and 21.6 – 43% respectively, there is a need to look at the sample population for explanations of this finding.

Family income plays a role in food intake since it limits quantity or quality of food. Many, if not the majority, of individuals who seek care at schools of dentistry do so for economic reasons.[96] However, there was no evaluation of family income in the study. It is therefore unknown whether that assumption holds true in this study cohort.

The sample population has a higher proportion of males than the Canadian and Manitoba populations. Increased risk of malnutrition has been reported to being associated with females[125]. Although females made up 45% of the sample population, they formed 55% of the risk population, although this finding were not significant (NS, p=.479).

This population also reported a higher level of education, was more physically active, and reported smoking less than the general population. 93.1% self-reported being as healthy or healthier than their peers. 28.5% live alone. The Canadian Task Force on Preventive Care (1994)[118] identified that older adults living alone were at higher risk for malnutrition. The 'at risk' population in this

study that reported living alone formed 20% of that group. There were no significant associations between the 'at risk' and general sample population for this risk variable (NS, p=.528). The mean intake of prescription medications per day was 2.47. It is of interest to note that none of the 'at risk' population took more than 6 medications, whereas the range for the sample population was 0-15.

As a result of these differences, it is felt that the sample population is a healthier population than the general Canadian and Manitoban populations. It is important to be conservative when making statements that imply generalizability of results. While the relevance of the results is probably not restricted to the study population, it is important to be aware of their limitations. Given the fact that the study population is healthier and better educated than the general population, the study results may well underestimate the prevalence of risk of malnutrition in the general population.

That being said, the essential issue is that prevalence of risk exists in the orally functional and at a rate that is not significantly different from the orally compromised (NS p = .551). It has been suggested that tooth loss results in significant alterations to diet with tooth loss, resulting in highest risk to the edentulous. The results of this study did not demonstrate this finding, although the number of edentulous may have limited this finding. Although 25% of the sample population reported alterations to the diet, the difference between orally functional and orally compromised for alterations to food choice was not significant (NS, p = .436).

5.2 Identifying Explanatory Variables for Malnutrition

Other studies have identified the association between xerostomia and malnutrition.[111] The results of this study demonstrated a similarly high association between xerostomia and risk of malnutrition with those subjects reporting to have dry mouth found to be almost 8 times more at risk than those not dry. Additionally, it was found that dry mouth explained the influence of medications, problems with speech, and dissatisfaction with the oral condition. Clinicians need to be cognizant of dry mouth as a risk indicator for nutritional difficulties.

Although significant findings were not determined in this study between those subjects who were orally compromised to those orally functional, 'being satisfied with the ability to chew' probably addresses this issue. This finding better explains the dichotomy between patients who shouldn't thrive due to their dental status, yet do well, rather than quantification of numbers of teeth present. This finding demonstrates the importance for prosthesis to be comfortable to allow ease of function, a finding that had been emphasized in the literature.[105]

A non-oral/dental risk variable identified in this study was 'where subject grew up'. Subjects who grew up rural were almost 8 times less likely to experience risk of malnutrition. This variable also explained the variable 'physical activity'. Other studies have reported that subjects who grew up rural were at lower risk for malnutrition[126,127] and that rural and urban elderly view health differently[128] with older rural subjects displaying higher levels of morale.[129]

In this study, 91% of the subjects who were totally inactive grew up urban, while 55% of those who were physically active 7 times per week grew up rural. (Appendix J) Public transportation in rural Canada was (and still remains) uncommon, many families did not own motor vehicles, and motor fuel use was rationed for farm implements use necessitating travel by foot. Perhaps because this age cohort grew up with a tradition of manual labour and walking to attend school and social functions, this tradition may be a reflection of these findings. In contrast, present studies are examining the relationship between rural residents < 65 years and increasingly lower levels of activity and higher levels of obesity. [130,131]

Finally, increasing age is a risk determinant for almost all debilitations, this one being no exception.

5.3 Conceptual Model

It is disconcerting that restoration of the dentition with removable prosthesis does not result in significant alterations to dietary intake. The conceptual model that was developed for this study offers suggestions for this finding. The role of the oral/dental complex, although physically essential, is not limiting and is outweighed by numerous other risk variables and determinants. The value of this model is to visualize this role in order to gain an appreciation for the lack of impact with restoration of the dentition.

5.4 Use Of Diagnostic Tools To Identify Subjects At Risk

Although there is increasing advocacy for dietary counseling by oral healthcare professionals to improve dietary intake, there is only one article in the literature that reports on changes following counseling for dental patients. That may reflect a variety of concerns.

Dentists are not comfortable with dietary counseling or with assessing fees for counseling, particularly to individuals that can least afford additional fees. Central to this issue is that diagnosis must precede treatment. A potential reason for lack of diagnosis has been that diagnostic tools have not been identified for the practitioner. The Mini Nutritional Assessment, used in this study, did identify subjects at risk for malnutrition. Without blood testing, the validity of the MNA for this study is unknown, although it has been validated in many previous studies. The value of the dental community as a surveillance group for the identification of nutritional deficiencies is strongly advocated. Referral for dietary counseling is recommended following definitive diagnosis of malnutrition .

5.5 Applications Of Study For Clinical Practice

5.5.1 Modified MNA For Community-Living Older Adults

The determined Cronbach's alpha value of 0.585 for the MNA suggests that reliability for diagnosis of malnutrition for community-living older adults might be improved by using a modified MNA. A modified MNA would replace risk variables that do not reflect this population's risk (mobility, living independently, presence of pressure sores or ulcers, mode of feeding) with the four variables

that were found in this study to be significantly associated with risk of malnutrition.

5.5.2 Predicting Individuals Who Are At Increased Risk Of Malnutrition

Because generalized screening of all patients for malnutrition is not advocated by the Canadian Task Force on Preventive Care,[118] using predictors may be an effective way of identifying those patients who should be screened. Combined, the MNA and Satisfaction with Oral Condition instruments were effective in identifying 'at risk' subjects. The regression model summarized in Table 4.10 was used to estimate the probability of being at risk of malnutrition. Of the four risk variables in the final regression model, three are categorical, resulting in eight possible risk combinations that may arise (2x2x2x). The fourth risk variable, age, is continuous. For illustrative purposes, risks have been calculated for two ages, a 65 year old and a 90 year old, resulting in 16 potential risk situations. These combinations and consequently the expected prevalence/1,000 of risk of malnutrition faced by individuals in each of these 16 situations are presented in Table 5.1. These combinations could be useful predictors for selection of priority for screening if the decision is made not to screen every patient.

Table 5.1

Estimated prevalence of risk of malnutrition under specified conditions

Mouth Dry	Grew Up	Chewing Ability	Prevalence/1,000 Age 65	Age 90
Dry	Urban	Not. Sat.	510	976
Dry	Urban	Sat.	151	872
Dry	Rural	Not. Sat.	116	835
Dry	Rural	Sat.	22	464
Wet	Urban	Not Sat.	118	839
Wet	Urban	Sat.	22	469
Wet	Rural	Not Sat.	17	395
Wet	Rural	Sat.	3	100

5.6 Limitations of the Study

There were several limitations to this study:

1) Although this was a preliminary study that resulted in the identification and quantification of four variables associated with malnutrition, the Satisfaction with Oral Condition Questionnaire was not a previously validated instrument.

2) Previous studies have not separated subjects into orally compromised and orally functional, rather, more simply into dentate and edentulous. It is anticipated that the current study's classification may be controversial. However, it is felt that function may better explain dietary intake than simply presence or absence of teeth.

3) Only 15 subjects were completely edentulous.

4) Income was not determined for the respondents.

5) Alcohol abuse was not investigated in this population.

6) Neither cultural nor ethnic diversities were determined in this population.

7) Based on sex, weekly participation in physical activity, and highest level of schooling, the sample population is healthier and more educated than the general Canadian and Manitoban population. This may result in an underestimation of the prevalence of risk of malnutrition in the general population.

5.7 Conclusions

1) Although no malnutrition was reported in this study, risk of malnutrition exists and at similar rates for orally functional and orally compromised subjects.

2) A proposed Conceptual Model was useful for explaining inconsistencies found in previous research. The Model may also be useful for explaining some prosthetic treatment outcomes.

3) Nutritional screening tools such as the Mini Nutritional Assessment could be used for preliminary diagnosis of malnutrition in the dental office.

4) This study has identified risk variables which, when present, could alert the practitioner to apply a validated nutritional screening test

5.8 Recommendations

The following recommendations are based on the results of this study.

1. Oral healthcare providers should screen older community-living patients for diagnosis of malnutrition.

2. The MNA is a useful diagnostic tool for screening malnutrition in older adults. It would be prudent to utilize all 18 questions to ensure that everyone at risk is identified. The MNA should be modified to improve its reliability for use among community-living older adults. The modified instrument should then be tested and ultimately utilized by oral health professionals.

3. Diagnosis of malnutrition through nutritional screening tools should be added to the curriculum for dental students.

4. Further studies in other parts of Canada and with younger age cohorts should be conducted to measure the association for 'growing up rural' and malnutrition. Because the association is strong (OR 7.937) and it is suggested in the literature that this trend has reversed with the mechanization of agriculture, it is worthy of further research.

APPENDICES

Appendix A
Human Subjects Approval

Approval for conducting this research was received from the University of Manitoba Heath Research Ethics Board on August 27, 2005.

UNIVERSITY OF MANITOBA

BANNATYNE CAMPUS
Research Ethics Boards

P126-770 Bannatyne Avenue
Winnipeg, Manitoba
Canada R3E 0W3
Tel: (204) 789-3255
Fax: (204) 789-3414

August 22, 2005

Dr. Nita Mazurat
D226M, 780 Bannatyne Avenue
Winnipeg, MB R3E 0W2

Dear Dr. Mazurat:

Re: H2005:162
"Risk of malnutrition among orally compromised community living older adults"

In response to your submission dated July 25, 2005 the above-named study was reviewed by the full board at the meeting of the Health Research Ethics Board on August 22, 2005 and will be considered for approval conditional to the following:

- The committee was concerned that the procedure envisioned by you involves a very tight time frame. Approval is conditional upon you first determining that the time frame can be accommodated.
- You state that the individual is given an option whether or not results are to be sent to the physician. The committee is curious as to why you are including this particular option – the results themselves may not have particular relevance to the patient's continuing medical record and this option will involve significant additional work which should have some offset benefit.
- Is ≤ 20 a useful dental standard? Is it not significant what teeth are missing? Please comment.

Your response to the above is required prior to consideration of this study for approval.

Yours sincerely,

Ken Brown, MD, MBA
Chair, Health Research Ethics Board
Bannatyne Campus

KB/bz

Appendix B
Institutional Approval

Permission to conduct research within the Faculty of Dentistry was received July 4, 2005.

UNIVERSITY OF MANITOBA | Faculty of Dentistry

Dean's Office
D113-780 Bannatyne Avenue
Winnipeg, Manitoba
Canada R3E 0W2
Telephone: (204) 789-3631
Fax: (204) 789-3912
dean_dent@umanitoba.ca

4 July 2005

Dr. Nita Mazurat
Department of Restorative Dentistry
Faculty of Dentistry

Dear Dr. Mazurat,

I am writing in response to your note of 27 June 2005.

The Faculty supports your proposal to carry out a study on malnutrition on a group of patients aged 65 and over in our clinics, subject to your obtaining ethical approval from the appropriate University committee.

I wish you every success in this project.

Sincerely,

N. Fleming Ph.D.
Associate Dean (Research)

Appendix C

Permission to copy the validated test instrument, the Mini Nutritional Assessment (MNA) was received from Nestles International on July 13, 2005.

Nestlé USA

800 NORTH BRAND BLVD
GLENDALE, CA 91203

Nestleusa.com

NUTRITION DIVISION
NESTLÉ BRANDS COMPANY

July 13, 2005

Dr. Nita Mazurat
D226M, 780 Bannatyne Avenue
Winnipeg, Manitoba
CANADA. R3E OW2

Re: Permission to Copy

This responds to your request to copy the following Nestlé materials:

- Mini Nutrition Assessment

Nestle USA, Inc., hereby grants you the permission to reproduce up to seven hundred (700) copies of the materials listed above ("Materials"). Reproduction of any of the Materials is subject to the following terms and conditions:

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Nestlé USA, Inc.

Cynthia Brown
Director, Clinical Research

Agreed to and accepted by this 14 day of July, 2005:

_____

Appendix D

Mini Nutritional Assessment

http://www.mna-elderly.com/practice/user_guide/user_guide_screening.htm

NESTLE NUTRITION SERVICES

Nestlé

Mini Nutritional Assessment
MNA®

Last name: First name: Sex: Date:

Age: Weight, kg: Height, cm: I.D. Number:

Complete the screen by filling in the boxes with the appropriate numbers.
Add the numbers for the screen. If score is 11 or less, continue with the assessment to gain a Malnutrition Indicator Score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe loss of appetite
1 = moderate loss of appetite
2 = no loss of appetite ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed/chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F Body Mass Index (BMI) (weight in kg) / (height in m)²
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

Screening score (subtotal max. 14 points) ☐☐
12 points or greater Normal – not at risk – no need to complete assessment
11 points or below Possible malnutrition – continue assessment

Assessment

G Lives independently (not in a nursing home or hospital)
0 = no 1 = yes ☐

H Takes more than 3 prescription drugs per day
0 = yes 1 = no ☐

I Pressure sores or skin ulcers
0 = yes 1 = no ☐

J How many full meals does the patient eat daily?
0 = 1 meal
1 = 2 meals
2 = 3 meals ☐

K Selected consumption markers for protein intake
- At least one serving of dairy products (milk, cheese, yogurt) per day? yes ☐ no ☐
- Two or more servings of legumes or eggs per week? yes ☐ no ☐
- Meat, fish or poultry every day yes ☐ no ☐

0.0 = if 0 or 1 yes
0.5 = if 2 yes
1.0 = if 3 yes ☐.☐

L Consumes two or more servings of fruits or vegetables per day?
0 = no 1 = yes ☐

M How much fluid (water, juice, coffee, tea, milk...) is consumed per day?
0.0 = less than 3 cups
0.5 = 3 to 5 cups
1.0 = more than 5 cups ☐.☐

N Mode of feeding
0 = unable to eat without assistance
1 = self-fed with some difficulty
2 = self-fed without any problem ☐

O Self view of nutritional status
0 = views self as being malnourished
1 = is uncertain of nutritional state
2 = views self as having no nutritional problem ☐

P In comparison with other people of the same age, how does the patient consider his/her health status?
0.0 = not as good
0.5 = does not know
1.0 = as good
2.0 = better ☐.☐

Q Mid-arm circumference (MAC) in cm
0.0 = MAC less than 21
0.5 = MAC 21 to 22
1.0 = MAC 22 or greater ☐.☐

R Calf circumference (CC) in cm
0 = CC less than 31 1 = CC 31 or greater ☐

Assessment (max. 16 points) ☐☐.☐

Screening score ☐☐

Total Assessment (max. 30 points) ☐☐.☐

Malnutrition Indicator Score

17 to 23.5 points at risk of malnutrition ☐
Less than 17 points malnourished ☐

Ref. Guigoz Y, Vellas B and Garry PJ. 1994. Mini Nutritional Assessment: A practical assessment tool for grading the nutritional state of elderly patients. *Facts and Research in Gerontology*. Supplement #2:15-59.
Rubenstein LZ, Harker J, Guigoz Y and Vellas B. Comprehensive Geriatric Assessment (CGA) and the MNA. An Overview of CGA, Nutritional Assessment, and Development of a Shortened Version of the MNA. In: "Mini Nutritional Assessment (MNA): Research and Practice in the Elderly". Vellas B, Garry PJ and Guigoz Y, editors. Nestlé Nutrition Workshop Series. Clinical & Performance Programme, vol. 1. Karger, Bale, in press.

Appendix E

Satisfaction with Oral Condition Questionnaire

Study number_____ Sex M F Year of birth_____

Highest level of education:
□ Elementary □ Junior high □ High school □ Trades training □ University

Area where mostly grew up:
□ Rural □ Urban

1. Are you satisfied with your overall oral condition? □ Yes □ No
2. Are you satisfied with your ability to bite? □ Yes □ No
3. Are you satisfied with your ability to chew? □ Yes □ No
4. Are you satisfied with the appearance of your teeth? □ Yes □ No
5. Are you satisfied with your speech? □ Yes □ No
6. Does your mouth feel dry most of the time? □ Yes □ No
7. If you have lost three or more teeth, did you feel that losing these teeth affected the foods you chose to eat? □ Yes □ No
8. Did you ever smoke tobacco □ Yes □ No
9. Do you still smoke tobacco? □ Yes □ No

   How much? _____pk/wk

Oral status_____ MNA _____
Number of anterior teeth _____
Number of posterior teeth _____
Number of posterior pairs _____
Why were teeth lost _____
Prosthesis:
Maxillary _____
Mandibular _____

How many _____ How long _____

Other comments

Appendix F
Summary of data

F.1 Summary from MNA

Mobility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	173	100.0	100.0	100.0

Independent living

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	173	100.0	100.0	100.0

Mode feed - self-feeding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	173	100.0	100.0	100.0

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	95	54.9	54.9	54.9
	female	78	45.1	45.1	100.0
	Total	173	100.0	100.0	

Age in years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	64	1	.6	.6	.6
	65	12	6.9	6.9	7.5
	66	11	6.4	6.4	13.9
	67	10	5.8	5.8	19.7
	68	9	5.2	5.2	24.9
	69	12	6.9	6.9	31.8
	70	11	6.4	6.4	38.2
	71	13	7.5	7.5	45.7
	72	8	4.6	4.6	50.3
	73	8	4.6	4.6	54.9
	74	10	5.8	5.8	60.7
	75	14	8.1	8.1	68.8
	76	8	4.6	4.6	73.4
	77	6	3.5	3.5	76.9
	78	9	5.2	5.2	82.1
	79	5	2.9	2.9	85.0
	80	10	5.8	5.8	90.8
	81	4	2.3	2.3	93.1
	82	7	4.0	4.0	97.1
	84	1	.6	.6	97.7
	85	1	.6	.6	98.3
	88	2	1.2	1.2	99.4
	92	1	.6	.6	100.0
	Total	173	100.0	100.0	

Intake

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1.7	1.7	1.7
	1	21	12.1	12.1	13.9
	2	149	86.1	86.1	100.0
	Total	173	100.0	100.0	

0 - Severe loss of appetite
1 - Moderate loss of appetite
2 - No loss of appetite

Weight loss in last 3 months

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	11	6.4	6.4	6.4
	1	4	2.3	2.3	8.7
	2	25	14.5	14.5	23.1
	3	133	76.9	76.9	100.0
	Total	173	100.0	100.0	

0 - Greater than 3 kg
1 - Does not know
2 - Between 1 and 3 kg
3 - No weight loss

Experienced Stress or acute disease in last 3 months

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	28	16.2	16.2	16.2
	2	145	83.8	83.8	100.0
	Total	173	100.0	100.0	

0 - Yes
1 - No

Depression

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1.7	1.7	1.7
	1	32	18.5	18.5	20.2
	2	138	79.8	79.8	100.0
	Total	173	100.0	100.0	

0 - Severe
1 - Mild
2 - None

BMI

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1.7	1.7	1.7
	1	7	4.0	4.0	5.8
	2	18	10.4	10.4	16.2
	3	145	83.8	83.8	100.0
	Total	173	100.0	100.0	

0 - Less than 19
1 - 19 to less than 21
2 - 21 to less than 23
3 - 23 or greater

Polypharmacy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	52	30.1	30.1	30.1
	1	121	69.9	69.9	100.0
	Total	173	100.0	100.0	

0 - Takes more than 3 prescription drugs per day
1 - Takes less than 3 prescription drugs per day

Pressure sores or skin ulcers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1.7	1.7	1.7
	1	170	98.3	98.3	100.0
	Total	173	100.0	100.0	

0 - Present
1 - Not present

Full meals

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	18	10.4	10.4	10.4
	1	55	31.8	31.8	42.2
	2	100	57.8	57.8	100.0
	Total	173	100.0	100.0	

0 - 1 meal/day
1 - 2 meals/day
2 - 3 meals/day

Protein intake - total

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.0	20	11.6	11.6	11.6
	.5	60	34.7	34.7	46.2
	1.0	93	53.8	53.8	100.0
	Total	173	100.0	100.0	

0 - 0 or 1 for the following: yes for one serving per day of dairy products, 2 or more servings of legumes or eggs per week, 1serving meat, fish, or poultry per day
0.5 - if 2 are yes
1.0 - if 3 are yes

Dairy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	160	92.5	92.5	92.5
	1	13	7.5	7.5	100.0
	Total	173	100.0	100.0	

0 - consumes at least one serving per day
1 - does not consume at least one serving per day

Legumes/eggs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	131	75.7	75.7	75.7
	1	42	24.3	24.3	100.0
	Total	173	100.0	100.0	

0 - consumes two or more servings per week
1 - less than two or more servings per week

Meat/fish/poultry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	126	72.8	72.8	72.8
	1	47	27.2	27.2	100.0
	Total	173	100.0	100.0	

0 - consumes meat, fish, or poultry every day
1 - does not consume these foods daily

Fruit/vegetables

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	26	15.0	15.0	15.0
	1	147	85.0	85.0	100.0
	Total	173	100.0	100.0	

0 - does not consume two or more servings of fruits or vegetables per day
1 - does consume two or more servings of fruits or vegetables per day

Fluid intake

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	2.9	2.9	2.9
	1	31	17.9	17.9	20.8
	1	137	79.2	79.2	100.0
	Total	173	100.0	100.0	

0 - Less than 3 cups/day
1 - 3-5 cups
2 - more than 5 cups

Self-view of nutritional status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1.2	1.2	1.2
	1	13	7.5	7.5	8.7
	2	158	91.3	91.3	100.0
	Total	173	100.0	100.0	

0 - views self as being malnourished
1 - is uncertain of status
2 - views self as having no problems

Self-view of health status in comparison with other people of the same age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	9	5.2	5.2	5.2
	1	3	1.7	1.7	6.9
	1	57	32.9	32.9	39.9
	2	104	60.1	60.1	100.0
	Total	173	100.0	100.0	

0 - not as good
0.5 - does not know
1.0 - as good
2.0 - better

Mid-arm circumference

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	.6	.6	.6
	1	4	2.3	2.3	2.9
	1	168	97.1	97.1	100.0
	Total	173	100.0	100.0	

0.0 - Less than 21
0.5 - 21 to 22
1.0 - 22 or greater

Mid-calf circumference

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2.3	2.3	2.3
	1	169	97.7	97.7	100.0
	Total	173	100.0	100.0	

0 - Less than 31
1 - 31 or greater

total score

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	17.0	2	1.2	1.2	1.2
	19.0	3	1.7	1.7	2.9
	19.5	1	.6	.6	3.5
	20.0	2	1.2	1.2	4.6
	20.5	1	.6	.6	5.2
	21.5	2	1.2	1.2	6.4
	22.0	2	1.2	1.2	7.5
	22.5	3	1.7	1.7	9.2
	23.0	3	1.7	1.7	11.0
	23.5	2	1.2	1.2	12.1
	24.0	5	2.9	2.9	15.0
	24.5	2	1.2	1.2	16.2
	25.0	8	4.6	4.6	20.8
	25.5	10	5.8	5.8	26.6
	26.0	16	9.2	9.2	35.8
	26.5	4	2.3	2.3	38.2
	27.0	17	9.8	9.8	48.0
	27.5	15	8.7	8.7	56.6
	28.0	21	12.1	12.1	68.8
	28.5	16	9.2	9.2	78.0
	29.0	27	15.6	15.6	93.6
	29.5	4	2.3	2.3	96.0
	30.0	7	4.0	4.0	100.0
	Total	173	100.0	100.0	

Appendix F.2 Frequencies from Oral Satisfaction

Individual final score

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	at risk for malnutrition	20	11.6	11.6	11.6
	properly nourished	153	88.4	88.4	100.0
	Total	173	100.0	100.0	

Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	14	8.1	8.1	8.1
	2	35	20.2	20.2	28.3
	3	63	36.4	36.4	64.7
	4	27	15.6	15.6	80.3
	5	34	19.7	19.7	100.0
	Total	173	100.0	100.0	

1 - Elementary
2 - Junior high school
3 - High school
4 - Trades
5 - University

Upbringing - Rural/urban

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	90	52.0	52.0	52.0
	1	83	48.0	48.0	100.0
	Total	173	100.0	100.0	

0 - Town or city
1 - Smaller than town or in the country

Number of times physically active per week

N	Valid	173
	Missing	0
Mean		5.12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	11	6.4	6.4	6.4
	1	4	2.3	2.3	8.7
	2	16	9.2	9.2	17.9
	3	15	8.7	8.7	26.6
	4	14	8.1	8.1	34.7
	5	18	10.4	10.4	45.1
	6	6	3.5	3.5	48.6
	7	89	51.4	51.4	100.0
	Total	173	100.0	100.0	

Number of times socially active per week

N	Valid	173
	Missing	0
Mean		3.88

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2.3	2.3	2.3
	1	26	15.0	15.0	17.3
	2	30	17.3	17.3	34.7
	3	24	13.9	13.9	48.6
	4	23	13.3	13.3	61.8
	5	17	9.8	9.8	71.7
	6	6	3.5	3.5	75.1
	7	43	24.9	24.9	100.0
	Total	173	100.0	100.0	

Owns a hearing-aid

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	143	82.7	82.7	82.7
	1	30	17.3	17.3	100.0
	Total	173	100.0	100.0	

0 - Does not
1 - Does

Uses Hearing-aid (and owns one)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	19	11.0	61.3	61.3
	1	12	6.9	38.7	100.0
	Total	31	17.9	100.0	
Missing	System	142	82.1		
Total		173	100.0		

0 - Complies
1 - Does not comply

Lives alone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	123	71.1	71.5	71.5
	1	49	28.3	28.5	100.0
	Total	172	99.4	100.0	
Missing	System	1	.6		
Total		173	100.0		

0 - Does not live alone
1 - Lives alone

Actual number of prescription drugs taken daily

N	Valid	173
	Missing	0
Mean		2.47

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	30	17.3	17.3	17.3
	1	44	25.4	25.4	42.8
	2	31	17.9	17.9	60.7
	3	22	12.7	12.7	73.4
	4	18	10.4	10.4	83.8
	5	12	6.9	6.9	90.8
	6	7	4.0	4.0	94.8
	7	2	1.2	1.2	96.0
	8	3	1.7	1.7	97.7
	9	2	1.2	1.2	98.8
	10	1	.6	.6	99.4
	15	1	.6	.6	100.0
	Total	173	100.0	100.0	

Satisfaction with oral condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	138	79.8	79.8	79.8
	1	35	20.2	20.2	100.0
	Total	173	100.0	100.0	

0 - Satisfied
1 - Not satisfied

Satisfaction with ability to bite into food

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	143	82.7	82.7	82.7
	1	30	17.3	17.3	100.0
	Total	173	100.0	100.0	

0 - Satisfied
1 - Not satisfied

Satisfaction with ability to masticate

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	145	83.8	83.8	83.8
	1	27	15.6	15.6	99.4
	2	1	.6	.6	100.0
	Total	173	100.0	100.0	

0 - Satisfied
1 - Not satisfied

Satisfaction with appearance of dentition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	124	71.7	71.7	71.7
	1	49	28.3	28.3	100.0
	Total	173	100.0	100.0	

0 - Satisfied
1 - Not satisfied

Satisfaction with ability to speak related to oral condition not systemic condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	157	90.8	90.8	90.8
	1	16	9.2	9.2	100.0
	Total	173	100.0	100.0	

0 - Satisfied
1 - Not satisfied

Is oral cavity dry most of the time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	149	86.1	86.1	86.1
	1	24	13.9	13.9	100.0
	Total	173	100.0	100.0	

0 - Not dry most of the time
1 - Dry most of the time

Has losing teeth affected choice of foods

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	136	78.6	81.4	81.4
	1	31	17.9	18.6	100.0
	Total	167	96.5	100.0	
Missing	2	1	.6		
	System	5	2.9		
	Total	6	3.5		
Total		173	100.0		

0 - Not affected choice
1 - Affected choice

Has subject ever smoked tobacco

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	78	45.1	45.1	45.1
	1	94	54.3	54.3	99.4
	2	1	.6	.6	100.0
	Total	173	100.0	100.0	

0 - Never smoked
1 - Smoked

Does subject still smoke

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	158	91.3	91.3	91.3
	1	15	8.7	8.7	100.0
	Total	173	100.0	100.0	

0 - No longer smokes
1 - Continues to smoke

Cigarette packages/wk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	157	90.8	90.8	90.8
	0	1	.6	.6	91.3
	1	1	.6	.6	91.9
	1	2	1.2	1.2	93.1
	2	2	1.2	1.2	94.2
	2	3	1.7	1.7	96.0
	4	5	2.9	2.9	98.8
	7	1	.6	.6	99.4
	14	1	.6	.6	100.0
	Total	173	100.0	100.0	

Oral status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	functional	93	53.8	53.8	53.8
	orally compromised	80	46.2	46.2	100.0
	Total	173	100.0	100.0	

Numbers of anterior teeth

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	17	9.8	9.8	9.8
	2	1	.6	.6	10.4
	3	2	1.2	1.2	11.6
	5	3	1.7	1.7	13.3
	6	16	9.2	9.2	22.5
	7	3	1.7	1.7	24.3
	8	4	2.3	2.3	26.6
	9	4	2.3	2.3	28.9
	10	6	3.5	3.5	32.4
	11	21	12.1	12.1	44.5
	12	96	55.5	55.5	100.0
	Total	173	100.0	100.0	

Numbers of posterior teeth

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	21	12.1	12.1	12.1
	1	3	1.7	1.7	13.9
	2	4	2.3	2.3	16.2
	3	3	1.7	1.7	17.9
	4	7	4.0	4.0	22.0
	5	6	3.5	3.5	25.4
	6	8	4.6	4.6	30.1
	7	2	1.2	1.2	31.2
	8	14	8.1	8.1	39.3
	9	12	6.9	6.9	46.2
	10	13	7.5	7.5	53.8
	11	15	8.7	8.7	62.4
	12	14	8.1	8.1	70.5
	13	12	6.9	6.9	77.5
	14	16	9.2	9.2	86.7
	15	9	5.2	5.2	91.9
	16	12	6.9	6.9	98.8
	17	1	.6	.6	99.4
	20	1	.6	.6	100.0
	Total	173	100.0	100.0	

Numbers of occluding posterior pairs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	47	27.2	27.2	27.2
	1	11	6.4	6.4	33.5
	2	16	9.2	9.2	42.8
	3	16	9.2	9.2	52.0
	4	25	14.5	14.5	66.5
	5	18	10.4	10.4	76.9
	6	16	9.2	9.2	86.1
	7	12	6.9	6.9	93.1
	8	11	6.4	6.4	99.4
	10	1	.6	.6	100.0
	Total	173	100.0	100.0	

Appendix G
'At Risk Population' Profile

1. Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	9	5.2	45.0	45.0
	female	11	6.4	55.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

2. Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	65	1	.6	5.0	5.0
	68	1	.6	5.0	10.0
	69	1	.6	5.0	15.0
	70	2	1.2	10.0	25.0
	72	1	.6	5.0	30.0
	74	2	1.2	10.0	40.0
	75	1	.6	5.0	45.0
	76	2	1.2	10.0	55.0
	77	1	.6	5.0	60.0
	78	2	1.2	10.0	70.0
	80	1	.6	5.0	75.0
	81	1	.6	5.0	80.0
	82	2	1.2	10.0	90.0
	85	1	.6	5.0	95.0
	88	1	.6	5.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
age	20	65	88	76.00	5.974
Valid N (listwise)	20				

3. Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	.6	5.0	5.0
	2	5	2.9	25.0	30.0
	3	7	4.0	35.0	65.0
	4	4	2.3	20.0	85.0
	5	3	1.7	15.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

1 – Elementary
2 – Junior high school
3 – High school
4 – Trades training
5 – University

4. Where Grew up

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	17	9.8	85.0	85.0
	1	3	1.7	15.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

0 – Urban
1 – Rural

5. Times Physically Active/week

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	2.9	25.0	25.0
	1	1	.6	5.0	30.0
	2	2	1.2	10.0	40.0
	3	1	.6	5.0	45.0
	4	2	1.2	10.0	55.0
	5	1	.6	5.0	60.0
	7	8	4.6	40.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

6. Times Socially active/week

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1.2	10.0	10.0
	1	4	2.3	20.0	30.0
	2	5	2.9	25.0	55.0
	3	1	.6	5.0	60.0
	4	2	1.2	10.0	70.0
	5	3	1.7	15.0	85.0
	6	1	.6	5.0	90.0
	7	2	1.2	10.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

7. Lives alone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	16	9.2	80.0	80.0
	1	4	2.3	20.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

8. Number of prescription medications/day

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.2	10.0	10.0
	2	2	1.2	10.0	20.0
	3	6	3.5	30.0	50.0
	4	5	2.9	25.0	75.0
	5	3	1.7	15.0	90.0
	6	2	1.2	10.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

9. Satisfied with oral condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	12	6.9	60.0	60.0
	1	8	4.6	40.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

0 – Satisfied
1 – Not satisfied

10. Satisfied with ability to bite into foods

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	14	8.1	70.0	70.0
	1	6	3.5	30.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

0 – Satisfied
1 – Not satisfied

11. Satisfied with ability to chew

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	12	6.9	60.0	60.0
	1	8	4.6	40.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

0 – Satisfied
1 – Not satisfied

12. Satisfied with esthetics of teeth

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	11	6.4	55.0	55.0
	1	9	5.2	45.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

0 – Satisfied
1 – Not satisfied

13. Satisfied with ability to speak

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	15	8.7	75.0	75.0
	1	5	2.9	25.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

0 – Satisfied
1 – Not satisfied

14. Mouth is dry most of the time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	10	5.8	50.0	50.0
	1	10	5.8	50.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

0 – Not dry
1 – Dry

15. Food choices have been altered as a result of tooth loss

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	15	8.7	75.0	75.0
	1	5	2.9	25.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

0 – Not altered
1 – Altered

16. Ever smoked

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	8	4.6	40.0	40.0
	1	12	6.9	60.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

17. Still smoking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	16	9.2	80.0	80.0
	1	4	2.3	20.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

18. Number of packs smoked per week

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	16	9.2	80.0	80.0
	2	1	.6	5.0	85.0
	4	3	1.7	15.0	100.0
	Total	20	11.6	100.0	
Missing	System	153	88.4		
Total		173	100.0		

Appendix H
Univariate analysis for determination of significant risk variables from Satisfaction with Oral Condition Questionnaire

1. Education

education * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
education	1	1	13	14
	2	5	30	35
	3	7	56	63
	4	4	23	27
	5	3	31	34
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.063(a)	4	.900
Likelihood Ratio	1.084	4	.897
Linear-by-Linear Association	.019	1	.890
N of Valid Cases	173		

2. Area where grew up

rural * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
rural	0	17	73	90
	1	3	80	83
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.853(b)	1	.002		
Continuity Correction(a)	8.416	1	.004		
Likelihood Ratio	10.855	1	.001		
Fisher's Exact Test				.002	.001
Linear-by-Linear Association	9.796	1	.002		
N of Valid Cases	173				

O is urban
1 is rural

3. Physical activity level

physAct

indvscore	Mean	N	Std. Deviation
at risk for malnutrition	3.85	20	2.996
properly nourished	5.29	153	2.160
Total	5.12	173	2.308

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
physAct	Equal variances assumed	9.422	.002	2.665	171	.008	1.438
	Equal variances not assumed			2.076	21.658	.050	1.438

4. Social activity level

indvscore	Mean	N	Std. Deviation
at risk for malnutrition	3.00	20	2.224
properly nourished	4.00	153	2.230
Total	3.88	173	2.246

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
socAct	Equal variances assumed	.007	.935	1.886	171	.061	1.000
	Equal variances not assumed			1.890	24.269	.071	1.000

5. Hearing aid

hearingaid * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
hearingaid	0	17	126	143
	1	3	27	30
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.086(b)	1	.769		
Continuity Correction(a)	.000	1	1.000		
Likelihood Ratio	.089	1	.765		
Fisher's Exact Test				1.000	.530
Linear-by-Linear Association	.086	1	.769		
N of Valid Cases	173				

6. Live alone

live alone * indvscore Crosstabulationt

		indvscore		
		at risk for malnutrition	properly nourished	Total
live alone	0	16	107	123
	1	4	45	49
Total		20	152	172

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.800(b)	1	.371		
Continuity Correction(a)	.398	1	.528		
Likelihood Ratio	.852	1	.356		
Fisher's Exact Test				.441	.271
Linear-by-Linear Association	.796	1	.372		
N of Valid Cases	172				

7. Number of medications

indvscore	Mean	N	Std. Deviation
at risk for malnutrition	3.55	20	1.432
properly nourished	2.33	153	2.384
Total	2.47	173	2.324

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
nmeds	Equal variances assumed	2.861	.093	-2.239	171	.026	-1.223
	Equal variances not assumed			-3.273	34.693	.002	-1.223

8. Satisfied with oral condition

satiscond * indvscore Crosstabulation

		indvscore		Total
		at risk for malnutrition	properly nourished	
satiscond	0	12	127	139
	1	8	26	34
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.929(b)	1	.015		
Continuity Correction(a)	4.561	1	.033		
Likelihood Ratio	5.073	1	.024		
Fisher's Exact Test				.031	.021
Linear-by-Linear Association	5.895	1	.015		
N of Valid Cases	173				

9. Satisfied with ability to bite

bite * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
bite	0	14	130	144
	1	6	23	29
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.840(b)	1	.092		
Continuity Correction(a)	1.868	1	.172		
Likelihood Ratio	2.473	1	.116		
Fisher's Exact Test				.111	.091
Linear-by-Linear Association	2.823	1	.093		
N of Valid Cases	173				

10. Satisfied with ability to chew

chew * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
chew	0	12	133	145
	1	8	20	28
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.455(b)	1	.002		
Continuity Correction(a)	7.574	1	.006		
Likelihood Ratio	7.610	1	.006		
Fisher's Exact Test				.006	.006
Linear-by-Linear Association	9.400	1	.002		
N of Valid Cases	173				

11. Satisfied with appearance

look * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
look	0	11	114	125
	1	9	39	48
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.358(b)	1	.067		
Continuity Correction(a)	2.456	1	.117		
Likelihood Ratio	3.097	1	.078		
Fisher's Exact Test				.108	.062
Linear-by-Linear Association	3.339	1	.068		
N of Valid Cases	173				

12. Satisfied with speech

speech * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
speech	0	15	143	158
	1	5	10	15
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.615(b)	1	.006		
Continuity Correction(a)	5.462	1	.019		
Likelihood Ratio	5.635	1	.018		
Fisher's Exact Test				.017	.017
Linear-by-Linear Association	7.571	1	.006		
N of Valid Cases	173				

13. Mouth feels dry most of the time

dry * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
dry	0	10	140	150
	1	10	13	23
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	26.431(b)	1	.000		
Continuity Correction(a)	22.953	1	.000		
Likelihood Ratio	18.924	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	26.278	1	.000		
N of Valid Cases	173				

14. Did losing teeth affect the foods you choose to eat

food choic * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
food choic	0	15	121	136
	1	5	27	32
Total		20	148	168

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.522(b)	1	.470		
Continuity Correction(a)	.175	1	.675		
Likelihood Ratio	.491	1	.484		
Fisher's Exact Test				.543	.324
Linear-by-Linear Association	.519	1	.471		
N of Valid Cases	168				

15. Did you ever smoke tobacco

ever smok * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
ever smok	0	8	71	79
	1	12	81	93
	2	0	1	1
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.454(a)	2	.797
Likelihood Ratio	.569	2	.752
Linear-by-Linear Association	.224	1	.636
N of Valid Cases	173		

16. Are you still smoking tobacco

still smok * indvscore Crosstabulation

		indvscore		
		at risk for malnutrition	properly nourished	Total
still smok	0	16	143	159
	1	4	10	14
Total		20	153	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.311(b)	1	.038		
Continuity Correction(a)	2.691	1	.101		
Likelihood Ratio	3.329	1	.068		
Fisher's Exact Test				.061	.061
Linear-by-Linear Association	4.286	1	.038		
N of Valid Cases	173				

17. Number of packs/week

cigpackwk

indvscore	Mean	N	Std. Deviation
at risk for malnutrition	.63	20	1.317
properly nourished	.24	153	1.344
Total	.28	173	1.343

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
cigpackwk	Equal variances assumed	3.614	.059	-1.207	171	.229	-.385
	Equal variances not assumed			-1.226	24.470	.232	-.385

Appendix I
Logistic Regression

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	education	.014	1	.907
		rural	10.210	1	.001
		physAct	6.189	1	.013
		socAct	3.271	1	.071
		hearingaid	.051	1	.822
		live_alone	.745	1	.388
		nmeds	4.667	1	.031
		satiscond	5.406	1	.020
		bite	2.528	1	.112
		chew	8.789	1	.003
		look	3.469	1	.063
		speech	7.131	1	.008
		dry	25.110	1	.000
		food_choic	.500	1	.480
		ever_smok	.163	1	.686
		oralstatu	.540	1	.463
		age	6.540	1	.011
		sx	1.052	1	.305
	Overall Statistics		54.329	18	.000

Variables not in the Equation

			Score	df	Sig.
Step 1	Variables	education	.037	1	.847
		rural	9.520	1	.002
		physAct	5.651	1	.017
		socAct	3.105	1	.078
		hearingaid	.563	1	.453
		live_alone	1.533	1	.216
		nmeds	.579	1	.447
		satiscond	.602	1	.438
		bite	.198	1	.656
		chew	2.398	1	.122
		look	3.477	1	.062
		speech	2.907	1	.088
		food_choic	.019	1	.890
		ever_smok	.048	1	.826
		oralstatu	.000	1	.986
		age	5.069	1	.024
		sx	.338	1	.561
	Overall Statistics		31.972	17	.015
Step 2	Variables	education	.526	1	.468
		physAct	3.773	1	.052

		socAct	1.129	1	.288
		hearingaid	.707	1	.401
		live_alone	.766	1	.381
		nmeds	2.080	1	.149
		satiscond	.822	1	.364
		bite	.556	1	.456
		chew	3.168	1	.075
		look	3.505	1	.061
		speech	2.507	1	.113
		food_choic	.034	1	.853
		ever_smok	.047	1	.829
		oralstatu	.322	1	.570
		age	4.125	1	.042
		sx	1.048	1	.306
	Overall Statistics		23.609	16	.098
Step 3	Variables	education	.197	1	.657
		physAct	3.590	1	.058
		socAct	.997	1	.318
		hearingaid	2.734	1	.098
		live_alone	1.405	1	.236
		nmeds	1.305	1	.253
		satiscond	2.004	1	.157
		bite	1.605	1	.205
		chew	7.501	1	.006
		look	3.683	1	.055
		speech	3.407	1	.065
		food_choic	.160	1	.689
		ever_smok	.011	1	.917
		oralstatu	.178	1	.673
		sx	1.354	1	.245
	Overall Statistics		20.405	15	.157
Step 4	Variables	education	.587	1	.443
		physAct	2.631	1	.105
		socAct	.849	1	.357
		hearingaid	2.866	1	.090
		live_alone	2.082	1	.149
		nmeds	.178	1	.673
		satiscond	.028	1	.867
		bite	.531	1	.466
		look	1.098	1	.295
		speech	.748	1	.387
		food_choic	.294	1	.588
		ever_smok	.052	1	.820
		oralstatu	.007	1	.935
		sx	.657	1	.418
	Overall Statistics		11.840	14	.619

Appendix J - Cross-tabulations for univariate analysis of significant risk variables within MNA

1. Sex

Sex newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
sx	male	86	9	95
	female	67	11	78
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.898(b)	1	.343		
Continuity Correction(a)	.502	1	.479		
Likelihood Ratio	.893	1	.345		
Fisher's Exact Test				.352	.239
Linear-by-Linear Association	.892	1	.345		
N of Valid Cases	173				

2. Has intake decreased over last 3 months

Intake newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
intake	0	0	3	3
	1	11	10	21
	2	142	7	149
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	56.519(a)	2	.000
Likelihood Ratio	38.353	2	.000
Linear-by-Linear Association	56.028	1	.000
N of Valid Cases	173		

3. Weight loss over last 3 months

Weight loss newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
wt loss	0	5	6	11
	1	1	3	4
	2	20	5	25
	3	127	6	133
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.830(a)	3	.000
Likelihood Ratio	30.310	3	.000
Linear-by-Linear Association	38.676	1	.000
N of Valid Cases	173		

4. Experienced stress or acute disease in last 3 months

Stress/disease newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
stress/dis	0	16	12	28
	2	137	8	145
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	32.003(b)	1	.000		
Continuity Correction(a)	28.456	1	.000		
Likelihood Ratio	23.746	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	31.818	1	.000		
N of Valid Cases	173				

5. Experienced depression over last 3 months

Depression * newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
depression	0	1	2	3
	1	23	9	32
	2	129	9	138
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.925(a)	2	.000
Likelihood Ratio	15.512	2	.000
Linear-by-Linear Association	20.205	1	.000
N of Valid Cases	173		

6. BMI

BMI newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
bmi	0	0	3	3
	1	6	1	7
	2	14	4	18
	3	133	12	145
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.532(a)	3	.000
Likelihood Ratio	16.302	3	.001
Linear-by-Linear Association	16.176	1	.000
N of Valid Cases	173		

7. More than 3 prescription drugs per day

Number of drugs newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
ndrugsgt3	0	39	13	52
	1	114	7	121
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	13.134(b)	1	.000		
Continuity Correction(a)	11.322	1	.001		
Likelihood Ratio	11.927	1	.001		
Fisher's Exact Test				.001	.001
Linear-by-Linear Association	13.058	1	.000		
N of Valid Cases	173				

8. Experience pressure sores or skin ulcers

Skin ulcer newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
skin ulcer	0	2	1	3
	1	151	19	170
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.416(b)	1	.234		
Continuity Correction(a)	.078	1	.780		
Likelihood Ratio	1.012	1	.314		
Fisher's Exact Test				.310	.310
Linear-by-Linear Association	1.407	1	.236		
N of Valid Cases	173				

9. Number of full meals eaten per day

Full meals newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
full meals	0	14	4	18
	1	44	11	55
	2	95	5	100
Total		153	20	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.042(a)	2	.007
Likelihood Ratio	10.079	2	.006
Linear-by-Linear Association	8.836	1	.003
N of Valid Cases	173		

10. Protein intake per day

Protein intake newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
protein in	.0	16	4	20
	.5	50	10	60
	1.0	87	6	93
Total		153	20	173

O – 0 or 1 yes
1 – If 2 yes
2 – If 3 yes

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.297(a)	2	.071
Likelihood Ratio	5.318	2	.070
Linear-by-Linear Association	4.905	1	.027
N of Valid Cases	173		

11. Dairy intake daily

Dairy newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
dairy	0	143	17	160
	1	10	3	13
Total		153	20	173

O – Yes
1 – No

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.823(b)	1	.177		
Continuity Correction(a)	.809	1	.368		
Likelihood Ratio	1.497	1	.221		
Fisher's Exact Test				.177	.177
Linear-by-Linear Association	1.813	1	.178		
N of Valid Cases	173				

12. Legume/egg intake weekly

legum_egg * newrisk Crosstabulation

Count

		newrisk		Total
		Not at risk	At risk	
legum_egg	0	121	10	131
	1	32	10	42
Total		153	20	173

O – Yes
1 – No

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.139(b)	1	.004		
Continuity Correction(a)	6.634	1	.010		
Likelihood Ratio	7.121	1	.008		
Fisher's Exact Test				.010	.007
Linear-by-Linear Association	8.092	1	.004		
N of Valid Cases	173				

13. Meat/fish/poultry intake/daily

Meat/fish/poultry newrisk Crosstabulation

		newrisk		
		Not at risk	At risk	Total
m_fish_p	0	113	13	126
	1	40	7	47
Total		153	20	173

O – Yes
1 – No

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.701(b)	1	.402		
Continuity Correction(a)	.325	1	.569		
Likelihood Ratio	.670	1	.413		
Fisher's Exact Test				.427	.277
Linear-by-Linear Association	.697	1	.404		
N of Valid Cases	173				

14. 2 or more fruits or vegetables eaten daily

Fruit_veg newrisk Crosstabulation

		newrisk		
		Not at risk	At risk	Total
fruit_veg	0	21	5	26
	1	132	15	147
Total		153	20	173

O – Yes
1 – No

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.761(b)	1	.185		
Continuity Correction(a)	.988	1	.320		
Likelihood Ratio	1.553	1	.213		
Fisher's Exact Test				.190	.159
Linear-by-Linear Association	1.750	1	.186		
N of Valid Cases	173				

15. Fluid intake daily

Fluid intake newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
fluid intak	0	4	1	5
	1	26	5	31
	1	123	14	137
Total		153	20	173

O – Less than 3 cups
1 – 3–5 cups
Second 1 – More than 5 cups

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.222(a)	2	.543
Likelihood Ratio	1.116	2	.572
Linear-by-Linear Association	1.203	1	.273
N of Valid Cases	173		

16. Self-view of health

View health newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
view healt	0	5	4	9
	1	3	0	3
	1	48	9	57
	2	97	7	104
Total		153	20	173

0 – not as good
1 – not certain
2 – as good
3 – better

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.281(a)	3	.004
Likelihood Ratio	10.511	3	.015
Linear-by-Linear Association	9.381	1	.002
N of Valid Cases	173		

17. Midarm circumference

Midarm newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
midarm	0	0	1	1
	1	2	2	4
	1	151	17	168
Total		153	20	173

O – less than 21 cm
1 – 21 –22 cm
2 – 22+ cm

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.772(a)	2	.001
Likelihood Ratio	8.246	2	.016
Linear-by-Linear Association	13.643	1	.000
N of Valid Cases	173		

18. Midcalf circumference

Midcalf newrisk Crosstabulation

		newrisk		Total
		Not at risk	At risk	
midcalf	0	1	3	4
	1	152	17	169
Total		153	20	173

O - <31 cm
1>31

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16.118(b)	1	.000		
Continuity Correction(a)	10.392	1	.001		
Likelihood Ratio	9.080	1	.003		
Fisher's Exact Test				.005	.005
Linear-by-Linear Association	16.025	1	.000		
N of Valid Cases	173				

Appendix K

Physical Activity rural Crosstabulation

		rural		Total
		0	1	
physAct	0	10	1	11
	1	3	1	4
	2	9	7	16
	3	8	7	15
	4	6	8	14
	5	12	6	18
	6	2	4	6
	7	40	49	89
Total		90	83	173

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